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ABSTRACT

The Science of Alcohol Curriculum for American Indians uses the Medicine Circle and the "new science paradigm" to study the science of alcohol through a culturally relevant holistic approach. Intended for teachers and other educational personnel involved with American Indians, this curriculum aims to present a framework for alcohol education that integrates physical, spiritual, mental, and emotional perspectives. The rubric of science alone will not alter the impact that alcohol and alcohol abuse have had on the lives of some American Indian students. This unit of the curriculum focuses on the central nervous system (CNS) and its responses to moderate drinking and alcohol abuse. It discusses: (1) the Medicine Circle as a better model than the machine for studying the CNS; (2) the importance of culturally relevant education; (3) the structure of neurons, process of a synapse, and function of neurotransmitters; (4) effects of alcohol on neurons; (5) roles of the cerebrospinal fluid and the blood-brain barrier in brain functioning; (6) alcohol effects on the hindbrain, midbrain, and forebrain; (7) differences in alcohol reactions of high and low tolerance drinkers; (8) roles of different areas within the cerebral cortex and alcohol effects on them; (9) five common CNS disorders associated with alcohol abuse; and (10) a holistic approach to alcoholism treatment among American Indians. This training unit contains a participant booklet, 29 references, a glossary, 12 handouts and accompanying overhead transparencies, an evaluation form, and tips for a successful training session. (SV)

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Science of Alcohol Curriculum for American Indians
(SACAI)

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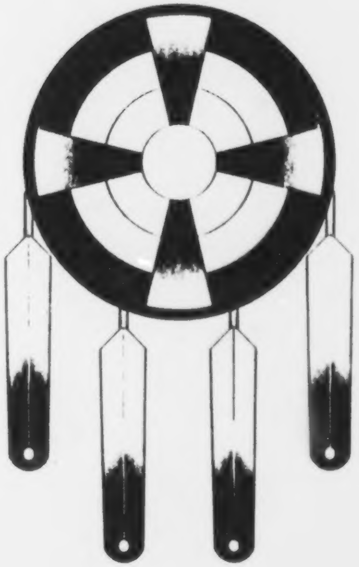

Training Unit

The Central Nervous System and Alcohol Use

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Science of Alcohol Curriculum for American Indians:
(SACAI)

The Central Nervous System and Alcohol Use

Training Unit

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American Indian Science and Engineering Society developed SACAI in an effort to address the devastating effects of alcohol among Indian populations. The SACAI approach is based on the belief that all things are connected and that successful prevention and intervention programs for American Indian students must start with this philosophical base. This connectedness is consistent with the new science paradigm and is symbolized in the curriculum by the Medicine Circle.

Many concerned and dedicated people played a part in the development and completion of this project. The content of the Teacher Training units was developed with the insight and dedication of three SACAI site coordinators: Ruth Bradford from the Pine Ridge Reservation in South Dakota; Artley Skenandore from the Oneida Reservation in Wisconsin; and Mark St. John from Isleta Pueblo in New Mexico.

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Cecelia Jacobs
SACAI Project Director

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USING THE SACAI UNIT

SACAI has been developed for use by trainers who have a background in biological science. The material provided in each unit is based on current research; however, the field of alcohol studies is rapidly changing and trainers should be aware of new theories and developments published regularly. The bibliography at the end of each unit provides information that can be helpful in staying current in alcohol studies. Although SACAI is targeted to teachers from grades 4 through 12, the training audience can include anyone interested in how alcohol affects the normal functions of the digestive and central nervous systems. This can include counselors, school health professionals, administrators, parents, and community members. SACAI emphasizes information of particular interest to teachers of American Indian students and includes a culturally relevant approach to presentation methods and explanations based on the concept of the Medicine Circle.

The SACAI materials include Training Units and accompanying Participant Booklets. The following units are currently available:

- Bridging American Indian Culture and the New Science Paradigm
- The Digestive System and Alcohol Use
- The Central Nervous System and Alcohol Use

It is strongly suggested that Bridging American Indian Culture and the New Science Paradigm preceed the use of other units. This first unit provides a grounding in alcohol issues and discussion of the Medicine Circle which is used throughout the curriculum. The remaining units can be studied in any order.

Each Training Unit includes presentation material, handouts, overheads (paper and transparent copies), activities and a bibliography. A Participant Booklet also accompanies each Training Unit. (Additional booklets are available from AISES.)

Training Unit

The Training Unit is presented in two columns. The left column, Presentation Background, contains the concepts and ideas to be presented. The right column, Presentation Notes, offers a variety of suggestions for engaging participants in the material. The Presentation Notes indicate when to use overheads, handouts, activities, or supplemental readings. These refer to and are associated with preceding paragraphs in the left column (Presentation Background). The Training Unit is designed so the user may easily follow the text from top to bottom on each page, alternating from column to column. The space provided throughout the unit may be used for your notes and comments.

Presentation Notes contain the following items:

1) Supplementary Readings: These suggested materials can be used to expand and enhance your understanding of the subject. They are listed in Presentation Notes with a full reference in the bibliography at the end of the unit. Depending on the time available and the size and interest of your class, you can make the readings optional, assign various material to small groups, request summaries--written or oral--from individual participants, ask for contrasts and comparisons of selected readings, assign cooperative learning activities, etc.

2) Overheads: Following specific text, overheads are provided to facilitate the training. Many of these are included in the Participant Booklet as "handouts". When an overhead is included in the booklet as a handout for participants, it is indicated in the Presentation Notes. Paper copies of the overheads are provided in the Training Unit along with transparencies.

3) Stories: Some units include stories written by American Indian authors or adapted from traditional stories. Participants should be encouraged to learn the stories common to the communities in which they work and to include them when appropriate in the learning process. The text of the stories is located after the handouts and overheads in this unit and the accompanying Participant Booklet.

4) Notes: Notes are used to offer information related to the text or to provide cultural perspective or background.

5) Discussion: Throughout the curriculum, open-ended questions are offered as a means to explore the material or its implications more fully. Trainers are encouraged to use the space provided to add questions of their own.

6) Activities: Ideas for class participation are offered, particularly at the beginning and end of the units, as warm-up and closing or review exercises. Many of these activities can be adapted for use in participants' classrooms. (Additional activities adaptable to classroom settings are listed in the Participant Booklets at the end of each section).

Participant Booklet

Accompanying the Training Unit is a Participant Booklet. Each participant should be given a booklet to facilitate the training. The booklet is divided into sections with discussion questions and activities following each section. The booklet also has pages for notes, a glossary of terms (when appropriate), and a bibliography. The content in the Participant Booklet is identical to that found in the Training Unit and it follows the same sequence. In addition to the activities and suggested readings found in the Training Unit, the Participant Booklet contains summary questions and training activities. These are designed to be used at the discretion of the trainer in conjunction with the activities found throughout the Training Unit in the Presentation Notes column.

Tips for a Successful Training Session

The following items are suggestions to consider in order to facilitate a successful training session. These ideas reflect effective strategies found over many years of research and experience in providing in-service training to educators. Suggestions are made specific to this unit.

1. Adequate preparation includes familiarity with the content, overheads, handouts and other materials.

2. If possible, participants should be provided the Participant Booklet prior to the training so they may familiarize themselves with the content.

3. The more interaction participants have with each other, the more involved in the training they will become.

4. Take adequate time to complete discussions and activities to ensure that all participants understand the content. The time needed will vary across training situations.

5. Provide culturally relevant examples and/or experiences whenever possible and encourage the participants to share their related experiences.

6. Allow participants the opportunity to discuss how the unit's content may be applied to the classroom setting when teaching students about the effects of alcohol.

THE CENTRAL NERVOUS SYSTEM AND ALCOHOL USE

Presentation Background

Presentation Notes

I. The Central Nervous System

The current paradigm of science describes the universe as functioning like a complex mechanical system. Even the evolution of cellular life is seen as a mechanistic process of mutation and natural selection that eventually resulted in a hierarchical arrangement of simple to complex organisms. At some point during this evolution a spectacular event occurred: unconscious matter became aware of itself. This event is not explained by current science. It is not even seriously attempted, yet the mechanistic view of the physical development is taken for granted. Consciousness is seen as the product of highly organized physical matter - the central nervous system (CNS).

Observations demonstrate that there is a close connection between consciousness and the brain, but they do not prove that consciousness is produced by the brain. Spiritual awareness, feelings of love, an emotional response to beauty, or a sense of connectedness with nature are not explained by the mechanistic paradigm that contends in the words of John Locke that "there is nothing in the intellect that had not first been processed through the senses" (Grof, 1985).

The Medicine Circle represents a more complete view of nature than the mechanistic model and includes in its description elements beyond perception by the senses. The wealth of profound knowledge about the human psyche and consciousness accumulated within ancient cultures and traditions from all over the world has not been adequately acknowledged or integrated by euro-ethnic science (Grof, 1985).

THE CENTRAL NERVOUS SYSTEM AND ALCOHOL USE

Presentation Background

As the nerves and brain are considered in this unit, emphasis is placed on the integration of a holistic perspective in understanding their functions. This includes the use of the Medicine Circle, American Indian stories, discussions and interactions.

In the following adapted story, a young Brule Sioux hunter learns how to make a flute from a teacher who comes to him during a vision. The vision is the source of new knowledge which contributes to the well-being of the individual as well as the village and the people to come. As we study about the brain and nerves we will refer to this legend to enhance and contextualize learning.

Adapted from: **The Legend of the Flute**
by Henry Crow Dog

Once many generations ago during the time of our grandfathers and grandmothers, the people had turtle shells, gourds and drums, but they had no flutes. During this time a young man who had no elk medicine decided to go hunting. He wanted to shoot an elk to bring the meat to his people. He also wanted to posses elk medicine because it would make him a good hunter. The elk, who is wise and swift, also has the power of the love charm. With this medicine, a man can choose the woman he likes to be his wife.

After walking for a full day, he sighted his game. His quiver was full of sharp tipped arrows that flew straight because of the new feathers on them, but the elk managed to stay out of range. The young

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hunter would retrieve his arrows and return them to his quiver, hoping to put them to better use next time that he shot them.

When night came, he realized he was lost in a forest. There was no moon and the elk was gone. He wrapped himself in his hide robe to keep warm and leaned against a tree to sleep. But he couldn't sleep. He heard too many sounds. He heard the cries of night animals and the groaning of trees in the wind. And then he heard a new sound. It was mournful and ghost-like, but also full of yearning and love. He fell asleep to this strange sound and dreamed of a woodpecker. This bird sang with the same sound he heard when he was awake. The woodpecker was telling the young man in his dream to follow him.

When he awoke, he saw the red head of the woodpecker who was flying from tree to tree and looking back as if to say, "Come with me". Then he heard the sound again and saw the bird fly toward it. At last, it lighted on a cedar tree and began to make holes in a branch. Then a gust of wind came and the hunter heard the beautiful sound again. "You can make another branch, Woodpecker. Let me take this branch home," he said.

He returned to his village with the stick. He tried very hard to make the sound with the stick, but could not do it. This made him sad so he purified himself in a sweat lodge and climbed to the top of a quiet hill. There he fasted for four days crying for a vision that would tell him how to

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make the branch sing. On the night of the fourth day the bird appeared and turned himself into a man. In this vision the man said, "Watch", and the young man watched very carefully.

When he awoke the next morning, he immediately began to follow the directions of the man in the dream. When he was finished he prayed and smoked the branch with burning sage, cedar and sweetgrass. Then he fingered the holes and blew softly into the hole at the end and the beautiful ghost-like sound drifted down to the village. With the help of the wind and the woodpecker, the young man had brought them the first flute.

In the village was the proud daughter of a big chief. Many had come courting her, but she had sent them all away. She was waiting for the right man. When she heard the flute she knew that she had found him. She said to the young man when she had found him, "I am yours altogether. Let your parents send a gift to my father." The parents agreed to the wishes of their children and soon they were married.

Other young men saw what happened and learned to make their flutes and to play them to bring their lovers to them. That is how the flute was brought to the people, thanks to the cedar, the woodpecker, and the young hunter who shot no elk, but knew how to listen (Crow Dog, 1967).

THE CENTRAL NERVOUS SYSTEM AND ALCOHOL USE

Presentation Background

By knowing the stories, legends and myths of communities in which they work, educators can create culturally relevant lessons for their students. This story from the Sioux tribe has components that are specific to the midwest tribes. Because of the large number of American Indian groups in the U.S. and the diversity within the groups, it is important for educators to choose stories from the particular communities their students represent.

II. The Nerves

Presentation Notes

Overhead 1: "Central Nervous System Mind Map"

Activity: Create a mind-map of the central nervous system to explore participants' current knowledge. (Another mind-map will be created as a review at the end of this unit.)
Ask participants for any words or ideas related to the CNS. Write suggestions on the CNS overhead (or blackboard) on the spokes of the circle. Main ideas may generate other related suggestions. For example, someone may say "brain" which would be written on a spoke. This may prompt another participant to say "left brain, right brain" which could be written on lines coming from the spoke that is labeled "brain". This branching can continue (with words like analytic, creative) or other main ideas can be added. After a short time, the mind map will become a cluster of words on spokes all grouped around the CNS circle. Although this cluster may look like an unorganized mass, it depicts non-linear relationships among ideas related to CNS.

THE CENTRAL NERVOUS SYSTEM AND ALCOHOL USE

Presentation Background

The nerve cell, or neuron, is the basic structural and functional component of the nervous system. Its shape makes it the ideal unit for information passage around the body. These cells are so important that they are all set in place from early embryonic development and are unable to divide. For this reason, once development has been completed, many neurons cannot be replaced when they die or are destroyed.

Neurons are specialized to receive, conduct, and transmit nervous impulses. Although they can differ widely in size and shape, each neuron consists of three main regions. 1) The dendrites carry information into the cell. 2) The soma, or cell body contains the nucleus and the information that the cell needs to form neurotransmitters (chemicals that pass information from cell to cell) and other proteins. 3) The axon carries information away from the cell body and releases neurotransmitters so that the next cell down the line is activated. At the end of the axon are terminal endings or boutons where neurotransmitters are released into the synaptic gap.

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Overhead 2: "Cynthia's Central Nervous System"

Note: Unlike the central neurons, peripheral neurons can regenerate to some extent.

Supplementary Reading: "The Nervous System and the Predisposition to Alcohol" by O'Connor, Hesselrock, and Baue in Alcohol, Health and Research World, 1990.

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Neurons are not actually in physical contact with one another. The synaptic gap that separates the axon tip of the transmitting (pre-synaptic) neuron from the receiving (post synaptic) neuron is about 20 nanometers - 20 billionths of a meter (Bloom and Lazerson, 1988). Interneuronal communication is accomplished by chemicals known as neurotransmitters. These chemicals are released from the axon, cross the synapse, and bind to the surface of the dendrite.

A fluid covering or membrane surrounds each neuron. This membrane has many functions including keeping

Presentation Notes

Note: There is a fatty covering over the axon called the Myelin sheath. Some American Indian groups "brain tan" leather by rubbing the leather with the brain of an animal. It is the Myelin sheath covering the nerves in the brain that makes the leather soft.

Overhead 3/Handout 1: "One of Cynthia's Neurons"

Discussion: The general shape of a neuron is not unique in nature. Like a fine net it stretches its dendrites and branching axon extensions outward to communicate with its environment. What other examples of this shape are obvious in nature (lightening, plant roots and branches, cracked ice, social behavior patterns and relationships, etc.).

Overhead 4/Handout 2: "Cynthia's Neuronal Communication"

Presentation Background

in needed substances such as glucose and amino acids, keeping toxins from entering the cell, and allowing metabolic wastes to be removed from the cell. Along with these maintenance functions, the neuronal membrane plays a role that is vital to the passage of information along the nerve, and the passage of that information to the next nerve in line. The key to this important role is that the neuron is impermeable to charged molecules, known as ions, and causes a separation of charge from the inside of the membrane to outside of the membrane. The inside of the cell is slightly more negative than the outside of the cell. This is an important factor in information travel since it is a disturbance in the normal membrane charge difference, or potential, that is transferred from cell to cell to be read by the brain as a message from the body or the environment. Activation of this system can come from inside or outside the body.

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Discussion: What are examples of stimulation of a neuron from outside the body? (light on the retina of the eye, cold or heat and on sensors of the skin) from the inside of the body? (when appproximately 300 ml of urine has accumulated in the bladder, the stretched cells stimulate neurons that transmit this information to the brain).

Supplementary Reading: "Ionic Bases of Resting and action potentials" from Neuron to Brain, by S. W. Kuffler, J.G. Nicholls and A. R. Martin, 1984.

Overhead 5: "Close Up One of Cynthia's Neurons"

Presentation Background

The signal that is moved down the cell is called an action potential. Its function is to move information down the cell from the dendrites, through the cell body to the axon and on to the boutons. Here the action potential causes the bouton membrane to release capsules (vesicles) of neurotransmitter into the space at the end of the nerve, the synaptic gap.

The action of information transfer from one cell to the next is called a synapse. The electrical activity of the action potential causes vesicles filled with neurotransmitters to be released. The vesicles move to the tip of the bouton and open and release neurotransmitters into the synaptic gap. The neurotransmitters then either activate or inhibit the receptors of the next neurons to behave in the same way.

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Discussion: During the 16th and 17th centuries, scientists speculated that neurons were hollow tubes through which gasses flowed. The gasses were thought to stimulate muscles. Can you think of how this theory was disproved? (Animals were dissected under water, when no gasses were observed to bubble up, the scientists went "back to the drawing board") (Bloom and Lazerson, 1988).

Why didn't the theory of electrical current occur to scientists previous to this time? (Although electricity was known at this time, it was very new information and its powers had not been applied to practical uses).

Overhead 6/Handout 3: "Action Potential"

THE CENTRAL NERVOUS SYSTEM AND ALCOHOL USE

Presentation Background

There are approximately 40 to 50 known neurotransmitters but generally speaking, there are only two messages one neuron can pass on to the next - excitation (one cell commands another to activity) and inhibition (the receiving cell is prevented from firing).

When neurotransmitters defuse across the synaptic gap they find receptor sites on post synaptic membranes to which they can bind. It is believed that these neurotransmitters have shapes that lock onto the shapes embedded in the post synaptic membrane, much as pieces of a jigsaw puzzle fit together, or the way that only a particular key can open a lock. Or like the proud daughter in "The Legend of the Flute", only the right suitor is accepted.

Once neurotransmitters are released into the synaptic gap and bind to their receptor, they are either rapidly broken down by enzymes that are specific for the type of neurotransmitter at a given site, or re-uptaken into the neuron from which they came (just as the young hunter returned his arrows to his quiver). The purpose of this is to insure that the desired effect only occurs for a short amount of time.

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Overhead 7/Handout 4: "Synaptic Transmission"

Discussion: How are single neurons like members of communities? How are thoughts or actions of one person multiplied by contact with others. If a neuron was not able to function properly, how might it affect the whole body?
Overhead 8/Handout 5: "Re-uptake"
The effects of neurotransmitters are terminated by re-uptake. This process is simply the removal of neurotransmitters

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Recreational drugs work by inhibiting the breakdown of neurotransmitters or inhibiting its re-uptake. Cocaine, for example, blocks the re-uptake of a specific neurotransmitter, dopamine, and keeps the effect occurring for a longer period of time. Since dopamine is thought to mediate the pleasurable or rewarding effects of drugs, the person feels euphoric or "up".

Effects of alcohol can readily be seen in all aspects of neuronal functioning. They may be particularly revealing in their relation to intoxicated

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from the synaptic gap by the boutons. The cell membrane surrounding the bouton contains a pump-like design that returns the neurotransmitters from the synapse directly into the pre-synaptic bouton giving the receiving cell only a brief exposure to the neurotransmitter.

Note: The binding of a neurotransmitter to the appropriate receptor sets off a chain of events within the receiving neuron. In some cases, these events stimulate the receiving neuron to fire, that is, to send an electric current down its own axon, carrying the message further along. In other cases, these events induce chemical changes associated with the formation of thoughts, emotions, or memories. These processes are carried out by a complex system within the cell. This system generally includes various enzymes, molecules known as second messengers, minerals such as calcium, and so-called coupling proteins that link the various components together (Charness, 1990).

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behavior at the synapses. Alcohol damages and destroys cells. The neurons respond to alcohol by adapting so as to attempt to maintain their functioning and survival. These homeostatic measures allow an organism to become tolerant of alcohol.

Not everyone's system responds in the same way to the presence of alcohol. Differences are obvious when individual responses to drinking are compared. The term "innate tolerance" describes differences in a person's initial sensitivity to alcohol (Harris and Buck, 1990).

Tolerance occurs when the brain adapts to alcohol and functions more or less normally in its presence. In fact, after this adaptation, alcohol becomes a requirement for normal functioning. Often withdrawal from alcohol results in adverse symptoms indicative of physical dependence. Two important consequences of tolerance are as follows: 1) the effect of a given dose of alcohol decreases as tolerance develops and 2) a greater dose of alcohol is required to produce an effect. In other words, tolerance means that more drug is needed to produce a particular effect. Individuals may become tolerant

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Note: The American Psychiatric Association and the World Health Organization define alcohol dependence as a syndrome with varying degrees of severity, manifested by compulsive use, tolerance, repeated withdrawal symptoms, consumption to relieve withdrawal symptoms, and continued use despite impairments in social, occupational, psychological, and physical function (R.M. Rose and J.E. Barrett, 1988).

to the desired effects of alcohol as well as to its unpleasant ones. Tolerance may develop after prolonged exposure to alcohol (protracted tolerance) or after a single exposure (acute tolerance).

Calcium causes neurons to release neurotransmitter into the synaptic gap. An example of tolerance occurs when alcohol inhibits the effect of ions on the membrane of a pre-synaptic neuron. As a response, the cell moves its vesicles which store neurotransmitters closer to the pre-synaptic membrane, clumping them together. This lowers the number of ions needed to trigger a release of neurotransmitters into the synapse. Therefore, even though fewer ions get through the neuronal membrane because of the presence of alcohol, more neurotransmitter is available in the synapse during intoxication.

Three major neurotransmitters affected by alcohol are norepinephrine, dopamine and serotonin. Increased norepinephrine production following chronic alcohol use has been reported. During alcohol withdrawal and after many of the acute symptoms of withdrawal have disappeared, release and activity increase (Tabakoff et al., 1990). This rise in norepinephrine may be linked to sleep disturbances

Discussion: What are other examples of tolerance in nature and society? How can tolerance in families or society be dysfunctional?

Supplementary Reading: "Tolerance" from Under the Influence, by Milam and Ketchum, 1987 and "The Process of Alcohol Tolerance and Dependence", by Harris and Buck in Alcohol Health and Research World, 1990.

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and altered temperature regulation that occur during and subsequent to alcohol withdrawal. Increased norepinephrine activity appears to affect rapid eye movement (REM) sleep, a stage of sleep associated with dreaming. During withdrawal, REM sleep increases causing a disruptive sleep pattern (Tabakoff, et al., 1990).

During alcohol consumption, the production and release of dopamine is increased (Tabakoff, Hoffman and Peterson, 1990). Studies indicate that some people have low levels of dopamine. It may be that they use alcohol to boost their low dopamine levels.

Serotonin acts as an inhibitor of pain pathways and its effect in the brain is believed to help control the mood of a person. It is also considered to be involved in sleep and dreaming (Somjen, 1983). Decreased serotonin levels are associated with antisocial personality disorders, violence and impulsive behavior (Tabakoff et al., 1990). Patients who experience major depression and some individuals who commit suicide have been found to have impaired function of the serotonin system. It's been noted that these problems are more prevalent in alcoholic populations.

The level of the major breakdown product (or metabolite) of serotonin is a good measure of how much serotonin an individual produces because for every one serotonin molecule used, you get a specific amount of the metabolite. This metabolite has been found to be low in alcoholics. This suggests two possibilities. One is that lowered serotonin activity may be an inherent trait of some alcoholics. The other possibility is that chronic drinking may lower serotonin activity.

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Studies suggest that alcohol intoxication may be a means to self-medicate by people who either have inherently low levels of serotonin or who have developed low serotonin levels as an adaptation to chronic heavy alcohol use. In one study, while alcoholic subjects were drinking, their serotonin levels were normal, but during withdrawal the levels become abnormally low. Interestingly, drugs that inhibit serotonin uptake by neurons (i.e., drugs which prolong the action of serotonin by allowing it to persist in the synapse) reduce alcohol intake in animals selectively bred to consume large amounts of alcohol. Moreover, research using humans has found a modest reduction in drinking when these drugs are taken.

Neurotransmitter turnover is defined as the amount of neurotransmitter produced, released, then used or recycled in a given time period. High turnover suggests high serotonin levels become obvious. Sedation, caused by serotonin, becomes apparent.

As alcohol consumption continues, low tolerance drinkers experience sleepiness. Massive doses drunk quickly, as in teenage chugging contests, can increase the serotonin depression so that the drinker falls into a coma and breathing stops completely. This lethal overdose is known as alcohol poisoning. Interestingly, chronic drinkers as well as high tolerant inexperienced drinkers seem to be able to physiologically adjust their neurochemistry to the effects of large quantities of alcohol. Adjustment in these drinkers seems to occur at the post-synaptic membrane where individual neurotransmitter receptors may become, or already may be, damaged. This means that they are unable to incorporate large amounts of serotonin and increased levels have no apparent effect on these people. It may be this reason that in many cases the heavy drinker seems less drunk or sedated that a non-tolerant drinker who has consumed less alcohol.

The neurotransmitters discussed above have mainly stimulatory effects in the brain. Not all neurotransmitters stimulate, some inhibit neuron activity. These are extremely important in the brain to modulate the effects of the other stimulatory neurotransmitters. These inhibitory neurotransmitters work to dampen responses or inhibit neuronal activity that may be inappropriate.

Gamma aminobutyric acid (GABA) is the major inhibitory neurotransmitter in the brain. It works by binding to a neuron and allowing for an increase in chloride ions to enter the cell. Chloride ions carry a negative charge with them. This lowers the membrane potential and makes it harder for an excitatory response to occur with stimulation of the cell. In this manner GABA acts as a brake for excitability.

When GABA levels are low, inhibition of neuron activity decreases. In other words, the neurons are more excitable. The personality effects of this are anxiety, irritability, and agitation. It is believed that drinking alcohol normally increases GABA levels in the brain. The infrequent drinker experiences a rise in GABA from drinking alcohol. Serotonin levels also increase from the alcohol and he gets sleepy and eventually passes out. The tolerant drinker (because of long term drinking or genetic predisposition) has fewer GABA receptors. With less receptors, less of the effects of GABA are seen. In actuality with the loss of receptors a tolerant drinker shows very different responses to

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increased GABA from drinking. When he drinks huge quantities, he experiences a decrease in GABA activity. He tends to become more agitated, excitable, stimulated and obnoxious instead of sedated and sleepy. The GABA system's responses to alcohol prob-ably best fit the observed behaviors of high and low tolerance, as a model of a neurochemical basis of alcoholism (Harris and Buck, 1990).

GABA neurons are some of the smallest and last to develop before and even after birth. They are sensitive to developmental damage by alcohol. This damage could be permanent and irreversible. Some children of alcoholics may have overall insufficient GABA, resulting in higher generic stress and energy levels. Alcohol might be more attractive to them as a tension reducer or stress reliever.

In contrast to GABA which is the major inhibitory neurotransmitter in the brain, glutamate is the major excitatory neurotransmitter in the brain. Inhibition of the function of this neurotransmitter should have roughly the same overall effect as increasing the function of GABA. One of the glutamate receptors is hypothesized to play a role in learning and memory, neuronal development, seizures, and brain damage resulting from a lack of oxygen in the brain. Activation of this receptor by glutamate results in large uptake of calcium by the neuron, which increases the responsiveness of this cell to stimuli. Research has shown that relatively low levels of alcohol reduce the uptake of calcium that occurs in response to glutamate.

Chronic exposure to alcohol results in a compensatory increase in sensitivity to the excitatory neurotransmitter glutamate. This increased sensitivity in turn may contribute to the neuronal hyperexci-

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tability and seizures that accompany withdrawl, signs of physical dependence.

The balance of incoming and outgoing elements is critically important to the health and vitality of neurons. Nutrients must get into neurons in adequate amounts and proportions to allow them to make repairs, feed themselves, and stay healthy and strong. Waste materials must be eliminated quickly and properly, or the cells become poisoned with their own wastes. Enzymes, hormones, fats and proteins must all be let into the cells at the right time and in the correct amounts or the cells' orderly functioning is damaged. Since cells make up tissues, and tissues are the components of major organs, any significant injury to cells eventually is felt throughout the body and affects how the body functions within itself as well as with others (Milam and Ketcham, 1981).

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Discussion: How might understanding how neurotransmitters impact alcohol consumption effect our attitudes about why people drink?

Note: In rodent neuronal membrane preparations, alcohol increased the ability of GABA to increase the passage of chloride ions into the neuron. There is evidence that tolerance to the hypnotic effects of alcohol may be the result of an adaption of the GABA-operated chloride channels to the presence of chronic alcohol. Chloride uptake was reduced in membrane preparations from chronically alcohol-fed animals.

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The presence of alcohol in the body causes damage to neuronal cell membranes so that ions cannot travel across the membranes in a normal fashion. Alcohol appears to cause cell membranes to become less organized. The proteins that normally float in a given orientation in a membrane slip into new positions. This disorganization causes the cell to be unable to send proper signals. Confusion and disorientation of the person is seen (this is the feeling of intoxication). In the neuronal membrane of the chronic alcohol drinker, the neuron tries to make up for the loss of organization by stiffening the membrane so that it is less of a fluid mosaic and more of a wall. If alcohol is removed from the membrane, the wall initially remains stiff. If the ions cannot pass through the wall, the cell begins

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Discussion: How does GABA contribute to the body's homeostatic balance? Can you think of analogies of the function of GABA in nature, the family, or society? How does an understanding of the function of GABA affect our judgments of people who are agitated and excitable when drinking?

Supplementary Reading: "Advances in Neurochemistry: A Leading Edge of Alcohol Research" by Tabakoff, Hoffman, and Peterson in Alcohol, Health and Research World, 1990.

Note: When glutamate receptor blockers were given to mice withdrawing from alcohol, seizures were also blocked, presumably as a result of reducing the activity of the receptor (Tabakoff, et al., 1990).

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to pass action potentials down the axon at a rapid rate due to the abnormal build-up of ions within a neuron.

Some tolerant drinkers are able to incorporate fatty acids (cholesterols) into their neuronal membranes so as to resist the disrupting effect of alcohol. This restores the function of the membranes and neurotransmitter ions can continue to pass through. The result of this is central to the concept of tolerance in which heavy drinkers can continue to function but light drinkers begin to slur, sway and stumble. We do not know why or exactly how heavy drinkers can do this. Most likely this is a genetic trait that removes an essential biological control that prevents most drinkers from drinking large quantities. It is not known whether this resistance to fluidization of the membranes occurs gradually, quickly, or whether heavy drinkers' membranes are stiffer to begin with.

The function of neurons is to communicate with all parts of the body and allow for the entire body to be aware of what is going on in and around itself. The dendrites take in information in the form of electrical impulses. They pass these impulses to the cell body where they then go out the axon to the next cell. All of the information that is passed along the nerves is processed together so that changes in any area can generate appropriate responses. The processing center for this information is the brain, the focus of the next section.

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Overhead 9/Handout 6: "Cell Membrane"

Activity: Current science is inclined to picture cell-tissue-organs-body as

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III. The Brain

The brain contains about 12 billion neurons. Although we do not know exactly how or where thinking takes place, we do know that a rhythmic interaction among neurons goes on continuously. The possibil-

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discrete building blocks culminating in the individual. An Indian world view or new science paradigm view would "see" this differently. The body might be described as different systems and forces that interact with one another as in a network, instead of a hierarchy of building blocks. Break into small groups and elaborate on this concept. Produce one or more illustrations depicting a new paradigm way to picture the relationships of the components.

Discussion: The nervous system is easily represented by the Medicine Circle. It has a physical, an emotional, a mental and a spiritual component. Balance is critical to the interaction of all of these components for the wholeness of the person and the community in which she interacts. In what ways does the analogy of a machine fall short in illuminating our understanding of the nervous system?

Discussion: Compare the brain to a community. We know that it is not just one member who makes that community work, but the interaction of all the members. Consider the number of contacts with other people that an individual has in one day. How is this individual like a neuron?

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ities for relaying information are almost infinite; one neuron can be linked to as many as 600,000 other neurons (Pearce, 1977).

When the brain malfunctions due to the disruptive effects of alcohol, information is not correctly received or sent out. Alcohol's effects are not limited nor specific to any particular area of the brain. All areas are affected - although some more quickly and extensively than others. The areas less critical to life functions are affected first before more essential centers. That is why judgment is altered before breathing.

In order to study the brain, we arbitrarily subdivide it. The brain can be subdivided in many different ways. For the purpose of understanding the

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Overhead 10/Handout 7: "Out of Balance"

Discussion: How can alcohol be incorporated into the Medicine Circle without disturbing the balance? How does someone who abuses alcohol disturb the balance of the family and community? How can balance be regained?

Discussion: "Brain researchers are now beginning to consider the brain as a form of hologram... a kind of photography that contains the entire photograph within any part or piece of the whole... When we speak of the brain as a hologram, we mean that even a single thinking cell reflects or incorporates the workings of the whole brain" (Pearce, 1977). How is this quotation illustrative of the Medicine Circle or the new science paradigm? How might the brain be a hologram of the entire planet?

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effects of alcohol on the brain, the divisions of hindbrain, midbrain and forebrain are useful. All of these areas are protected by the blood-brain barrier.

Glucose, oxygen and ions pass rapidly from the circulating blood into the cerebrospinal fluid of the brain. The tissue that separates the blood from this fluid is known as the blood-brain barrier. It is important to keep blood out of the brain because it often carries antibodies that destroy brain tissue. Cerebrospinal fluid is the substance that feeds the brain tissues. This fluid functions as the blood does in other parts of the body. It brings nutrients into the brain and takes waste products out.

Some substances travel quite easily across the barrier, such as glucose and ions. Other substances such as insulin enter only very slowly. Many substances cannot enter the brain at all. The differential entry rates are due to the presence of the blood-brain barrier. One of the important functions of the barrier is to keep toxins from crossing into the brain. Alcohol is a small molecule that can cross the membrane and enter the brain. The cells of the brain readily absorb the alcohol and become disorganized, causing the effects seen in a person who is drunk.

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Overhead 11/Handout 8: "Cross Section of Cynthia's Brain"

Overhead 12/Handout 9: "The Blood-Brain Barrier"

Discussion: How can the blood-brain barrier fit into the model of the brain as a community? Are there things that alcohol "lets in" to a community? A family? An individual?

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As noted above, the effects of consuming alcohol are different for different people. Small amounts of alcohol reach the blood-brain barrier of the moderate low-tolerance drinker. Aldehyde dehydrogenase is a major enzyme system of the body that breaks down and removes many aldehydes (e.g. formaldehyde) most of which are toxic to the system. In moderate drinkers, the aldehyde dehydrogenase system will pick up acetaldehyde, a metabolite of alcohol, before it has a chance to contact the blood-brain barrier. Several conditions may prevent this, however. If, for example, the aldehyde dehydrogenase system is overtaxed by poor nutrition, excess yeast in the body, or other aldehydes (Nutra-Sweet ends up as formaldehyde in the body, it may not be able to remove acetaldehyde fast enough. Acetaldehyde passes readily through the blood-brain barrier, even easier than alcohol itself. In addition, acetaldehyde tends to leave the blood-brain barrier open after it passes into the brain. In a sense, it deactivates the barrier so that other foreign chemicals may pass in and out, until the barrier can close again. Some people may have inherited less active aldehyde dehydrogenase enzymes.

When large amounts of alcohol are consumed, more acetaldehyde is produced, creating a greater opportunity for some of this poison to enter the brain. Interestingly, some of the unnatural aldehyde derivatives, condensed by the mixture of acetaldehyde and neurotransmitters, seem to have the ability to antagonize or inactivate the aldehyde dehydrogenase

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Overhead 13/Handout 10: "Acetaldehyde Tends to Leave the Blood-Brain Barrier Open"

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enzyme system, which is the very system necessary to remove acetaldehyde. A spiraling increase in acetaldehyde levels may result. The blood-brain barrier becomes chronically and progressively more ineffective in blocking alcohol and other chemicals which should not ordinarily get through.

III-A. Hindbrain

The hindbrain (sometimes referred to as brainstem) is the oldest portion of the human brain. It is the part of the brain that we have in common with all other members of the vertebrate world. It is located at the base of the brain and is directly connected with the spinal cord. This is the area where respiration, heart rate and some reflex action such as gagging and vomiting are controlled. This is the survival area of the brain that automatically controls the functions of the important organs of the body so that the body operates even when the person is a sleep or unconscious.

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Discussion: Compare the effects of alcohol on the brain to its effects on a basketball team. Greater amounts of alcohol have greater effects on the brain or on the community. Imagine a basketball team. With one player "drunk" the rest of the team may be able to compensate for that player and continue the game. But what if 2 or 3 or 4 players are "drunk". The team will have become too in-effective to play.

Discussion: You don't have to think about breathing or making your heart beat. What other functions might be governed by the hindbrain? Why are some

THE CENTRAL NERVOUS SYSTEM AND ALCOHOL USE

Presentation Background

Alcohol enters the cells of the hindbrain after crossing the blood-brain barrier and can sedate the breathing centers and other areas. One area of the hindbrain that is directly affected by alcohol is the sleep-wake cycle. It controls the level of awareness of the person. When it is active the person is awake and functioning. When it is inactive the person experiences drowsiness and low energy levels. Large amounts of alcohol can sedate this area of the brain which in turn causes the higher centers of the brain to be sedated. Once the higher areas are sedated there is little activation of the thinking portions of the brain. With complete sedation (alcohol poisoning), the individual falls into a coma. Death occurs if the brain does not recover. However, alcoholics rarely die from an overdose of alcohol. Low tolerance light drinkers are much more susceptible to disruptions in the hindbrain.

Alcohol can dissolve in the cell membrane and cause it to expand. This expansion, along with other alcohol induced changes in the layers of the membrane causes disorder (membrane fluidization) which disrupts the function of the membrane (Tabakoff, Hoffman, Peterson, 1990). The resistance to membrane fluidization seen in tolerant drinkers is thought to play a role in preventing sedation of the hindbrain, so that the heavy drinker does not get sleepy or pass out as easily as a nontolerant drinker.

The hindbrain also controls the vomit reflex after the ingestion of a toxin. By the time this area is activated the brain is often very sedated. If a drinker has already gone into a coma, he is at risk

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body functions beyond our conscious control?

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of aspirating vomit. This means that vomit is breathed into the lungs because the drinker is not awake enough to clear it from his mouth. This can cause pneumonia or even death by suffocation.

Both tolerant and light drinkers may vomit from drinking, although the tolerant drinker requires more alcohol to induce this response. There is no clear evidence and little research on how they may differ in this respect. Usually, people wake up just before they vomit, or they throw up before they pass out. However, if they are already in a coma, not just passed out (asleep), they may not wake up when they vomit, before they aspirate.

III-B. Midbrain

The midbrain is smaller and less differentiated than the hindbrain or forebrain. It works mainly as a relay center between the spinal cord and hindbrain and the forebrain. One area of the midbrain is involved in the feeling of strong emotion. It also involves the relay of visual and auditory information. This area is vital in insuring that information from the body and the environment reaches the forebrain, or thinking areas of the brain. Alcohol may sedate the midbrain so that the signals from the outside of the brain are not able to reach the forebrain or are slow in getting there. This means that the thinking portion of the brain is receiving little or no input. Of course, when it has no input it gives off no responses (Carpenter, 1976).

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Discussion: Imagine two communities that are dependent upon each other for information such as local politics, weather, and food supplies. A runner

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Certain circuits in the brain are thought to have reward or pleasure responses that are activated by alcohol, more so in some drinkers than others. Tolerant drinkers who attain more overall stimulation in the brain, as opposed to sedation, seem to achieve a more powerful, intense, and long lasting intoxication. Typically, all drinkers experience exaggerated emotions when drinking. This becomes greatly pronounced in tolerant drinkers whose emotions become polarized, rigid and extreme as the midbrain functions become predominant with increasing disruption of higher brain, intellectual functioning.

The hypothalamus is a particularly important control center. It resists the sedation of alcohol at all costs because it is necessary to survival. We have a rage center located in the hypothalamus. Again, consistent with the greater stimulation by alcohol of tolerant drinkers, this rage center may be overstimulated with extensive drinking. This may result in tiny localized seizure activity near the rage center which is thought to trigger uncontrollable anger and violent behavior, or at least lower the violence threshold. Up to 80% of all violent crimes, domestic violence, child abuse, rape, assaults, etc. are alcohol-related.

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travels between the communities with messages about these issues. One day the runner decides to walk slowly instead of running or even takes a long nap on the way. What might the effects be on the communities?

Overhead 14: "Polarized Vision of an Alcoholic"

Presentation Background

Memory centers are also located in the midbrain and the forebrain. It is interesting that violent rage reactions are often associated with blackouts (loss of memory of a period of time spent drinking). Significant reactions to alcohol such as these are always indicative of serious drinking problems, brain dysfunction and alcoholism.

III-C. Forebrain

Much of the forebrain is involved in intellect and coordinated movements and sensations. It is this region that is responsible for the "personality" and attitudes of a person. Incoming information from the midbrain synapses on the nerves of the forebrain. Different patterns of stimulation causes the forebrain to react in different ways. Some incoming information, for example, information about a pin in your finger causes the forebrain to send signals to the finger muscles to move away.

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Activity: Write an allegorical story that personifies alcohol in the environment of the brain. Share the story and the lessons in it with the other participants.

Note: You know how fast you move your finger away from a pin, it has been shown that information can travel up to 100 meters/second to insure rapid response to incoming information. Other types of incoming information causes the forebrain to respond by causing a verbal expression or adjustments in balance. When this system is sedated, loss of balance is a commonly seen side effect.

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Heavy drinkers tend to disable their higher brain centers more or less chronically. Their thinking processes tend to be shunted more and more to midbrain emotional centers. Often they begin to mistake their fantasies for reality, and replace normal cognition with rigid, extreme, black and white thinking patterns, often stereotypes. Frequently their self images are distorted. There are predictable long-term outcomes of higher brain toxicity. Moods also tend to become polarized and more extreme without the cognitive mediation of the outer forebrain.

Synaptic transmission is disrupted during drinking and the understanding of incoming messages is slowed and distorted. Outgoing responses are also interfered with, so that the total result is one of diminished functioning on all levels. The greater the quantity of alcohol ingested the greater the chemical disruption. Here again, the tolerant drinker's resistance to membrane fluidization and

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Overhead 15: "100 Meters/Second"

Overhead 16: "An Alcoholic's Distorted Self-Image"

Discussion: How can a teacher use this information in a classroom to help students understand and interpret alcoholic behavior? How can it help them make a paradigm shift in their thinking about people who drink?

Supplementary Reading: "Biochemistry: The Gateway to Excess" from Craving for Ecstasy: The Consciousness and Chemistry of Escape by Harvey B. Milkman and Stanley G. Sunderwirth, 1987.

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stimulation by alcohol may allow for some adjustment and less sedation. However, this does not mean that she is less intoxicated, but rather intoxicated differently from the light social drinker. This can be extremely dangerous. The light, nontolerant drinker loses his balance and coordination, becomes sleepy, and probably is not inclined to take unnecessary risks. The tolerant drinker, on the other hand, will be hyperactive and coordinated enough to try something foolish. She will not possess the judgment or intellectual controls to offset her fantasies about the glamorous nature of a potentially dangerous activity.

Think about the effects of an impaired forebrain functioning in a tolerant stimulated auto driver. Not only will she believe (feel) that she can make it home, she will tend to speed and pass four other vehicles on a hill, with her lights off. The nontolerant drinker knows that his brain is not working right and would be less likely to even try to drive.

III-D. Cerebral Cortex

Overhead 17/Handout 11: "Cynthia's Cerebral Cortex"

The cerebral cortex is the outer layer of the brain covering the left and right brain hemispheres. Of the approximately 12 billion neurons in the brain, 9 billion are in the cerebral cortex. Subdivisions of the cerebral cortex are the motor cortex, somatosensory cortex, and the association cortex (Thompson, 1975).

The motor cortex is the area of the brain that controls the movements of the body. This area is laid out in a map that corresponds to the placement of the body. If you artificially stimulate an area of

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the motor cortex you cause the related area of the body to move. Such a topographical map of the body in the brain is known as a homunculus which means "little body". This homunculus controls the movements of the body by sending information down specialized nerves that control body movement called motor neurons to the spinal cord and then out to the body. A disruption in any part of the pathway can lead to a disruption in the ability to move an area of the body properly. If a large area of the pathway is damaged, paralysis occurs. This is often seen in patients who have had strokes that damaged motor paths.

Alcohol can lead to disruption of the cells in the motor cortex that initiate the movement or in the pathway that the information must travel down. Disruption of the cells of the motor cortex causes inappropriate movements or lack of movement. An example of this is a person's inability to control normal bodily functions such as holding urine in the bladder. Disruption of normal motor pathways that work to control the opening to the bladder causes the bladder sphincter to open spontaneously and urine flows out.

Dopamine synapses are important to voluntary movement motor neurons. During initial stages of intoxication, movements become exaggerated and agitated. Later as post-synaptic receptors become disorganized, movements become uncoordinated and lethargic,

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Overhead 18/Handout 12: "Homunculus"

Supplementary Reading: "Alcohol and Cognition" by National Institute on Alcohol Abuse and Alcoholism, in Alcohol Alert No. 4, May 1989.

gait becomes unsteady because the peripheral nervous system does not receive activating impulses from the brain and spinal cord. Involuntary motor neurons are also affected. Eyes are wide open during initial intoxication, then become difficult to keep open or focused as the sedation sets in.

The area of the brain that receives sensory information from the outside world is the somatosensory cortex. It has a homunculus for the sensation of touch. Its function is to take all incoming information from the senses and integrate it in a manner that the individual can understand. The information coded here allows the person to make decisions regarding behavior.

Alcohol sedates the cells of the somatosensory cortex, causing all of the information coming in to be processed more slowly. Signals to other areas of the brain also move more slowly, as do all outgoing motor signals to the body. This is the other half of the drunk-driving danger. Disruption to the somatosensory cortex functioning prevents accurate assessment of incoming signals and impulses. Again for the heavy drinker, his midbrain tells him that he wants to pass that slowpoke ahead of him. His fantasy tells him that he is Mario Andretti and will surely make it. However, his somatosensory cortex cannot tell him accurately how much clear road he has ahead, how fast he is going in relation to the other cars, nor whether he sees the beginnings of oncoming headlights over the crest of the

Note: A social drinker urinates in his pants because of loss of motor neuron control. A tolerant drinker urinates on your lawn because it doesn't occur to him that it might be rude.

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hill. The information processing needed for these operations are complex and subtle, but his brain is chemically incapacitated. The alcoholic feels like his sensory system is just fine and that he will have no problem negotiating this intricate psychomotor project. Usually, the social drinker will have a better idea of when not to try.

The association cortex takes the incoming information and puts it in order so that the individual knows what she is seeing or hearing, etc. It is the "thinking portion" of the brain. Association nerves connect the information that comes in via the somatosensory cortex with information going out the motor cortex. Alcohol destroys the individual's ability to think. Judgment and reason are damaged and an inability to do anything except follow others is often seen. Damage here also causes dementia because the brain can no longer correctly assess the incoming information and it can incorrectly tell the person what is in the environment.

The association cortex is the seat of reason, judgment, fine discrimination. Without it we make no sense of the world we perceive and cannot choose appropriate responses or behaviors. It is made up

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Activity: In groups of two or three, write short stories of a community of people who function without full use of the association cortex.

Discussion: How does the physical disruption of the somatosensory cortex by alcohol affect the mental, emotional, and spiritual side of a person? How can alcohol cause a "backward" paradigm shift?

of complex columns and sub-areas. With alcohol, its functions are the first to be impaired. In order for messages to get up to the association cortex, they must take a long journey up the spinal cord, through the hindbrain and midbrain. When a person is intoxicated, messages do not get through accurately and intact in the first place. Then they cannot be interpreted and understood well in the association cortex. This, in part, explains inappropriate behavior associated with drinking alcohol. Alcohol is poisonous to every cell in the body; therefore, every aspect of a human being is poisoned by drinking. The greater the amounts, the greater the disruption, even though it may not always appear so.

The brain does not recover quickly from alcohol. Several hours are necessary after the drinking has ceased for the nervous system to recover normal functioning. First, a hyperactive rebound occurs that has physiological implications lasting about three times as long as the amount of time spent under the influence. The system is disrupted, dysfunctional and disorganized, even though there is no actual alcohol present in the body. A drinker who consumes significant amounts of alcohol daily never gives his body time to get through the rebounds. Eventually, the neurons, neurotransmitters, receptors, etc. become irreparably damaged. The brain cannot grow new neurons. It will slowly try to compensate and adapt to find new pathways in order to retain functions. However, if drinking continues, no compensation is possible and deterioration continues. The nervous system declines in a progressively toxic dying process, from the highest intellectual brain areas down through the entire being. The personality and thinking processes become less differentiated, the emotions

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become more extreme and stereotypic, behavior becomes more volatile and instinctual.

While the brain is composed of different areas that perform under different conditions the key to how we function is in the incredible integration of all the parts of our systems. There are areas that interpret sounds, others that interpret smells, and still others that control muscular movement and send signals out of the brain in response to incoming information, yet the end result is that we can do all of these things at one time. These areas all work together and when one area is damaged, all areas are affected.

IV. Alcohol-Induced Central Nervous System Disorders

As we have read, alcohol can damage the brain in many ways. The brain is susceptible to the toxic effects of alcohol itself and can also be affected by alcohol-related damage to other organs, such as the liver. Further, the nutritional deficiencies found in chronic alcoholics often play a role in CNS damage.

Alcohol acts on the CNS as a depressant. This depressant action disinhibits many higher cortical functions. Because of alcohol's depressant effects, parts of the CNS circuitry are released from their normal inhibitory roles. As a result, certain behaviors ordinarily restrained now occur. Acute intoxication induces mild delirium. Thinking, orientation, recent memory, and higher mental function-

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Supplementary Reading: "Neurochemical and Neurophysiological Variations" from Alcoholism: An Inherited Disease, by Peter L. Petrakis, 1985.

ing are compromised. Electroencephalograms (EEG) of intoxicated individuals show a diffuse slowing of normal brain waves. Some vulnerable individuals have a dramatic change of personality when they drink even small amounts and may become confused, disoriented, experience visual hallucinations, and be very aggressive, anxious, and impulsive. Described below are a few of the CNS disorders associated with heavy drinking.

Polyneuropathy is a disorder resulting from nutritional deficiencies of the B complex vitamins which weaken and eventually damage the peripheral nerves outside the brain and spinal cord. The first symptoms of polyneuropathy are numbness and tingling sensations in the extremities, usually the toes or fingers. As the condition worsens, the hands and arms, and feet and legs are affected. This disorder is reversible if treated early. In other words, the nerves will heal themselves if the alcoholic abstains from alcohol and eats a proper diet containing a balance of vitamins (particularly the B vitamins) and minerals. However, if the condition is not treated, the damage can become permanent and irreversible. Muscle tone is lost and muscles atrophy in these individuals. In late stage alcoholics with irreversible polyneuropathy, walking, when possible, is usually difficult and clumsy.

Wernicke's Syndrome is produced by a severe deficiency in Vitamin B1 or thiamine. A rapid onset of headaches, double vision, abnormal eye movements, the tingling sensations associated with polyneuropathy, muscular incoordination, stupor,

Supplementary Reading: "Nervous System" from Loosening the Grip by Kinney and Leaton, 1987.

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and brain hemorrhage are characteristic symptoms of Wernicke's encephalopathy. Moreover, a person with this syndrome is likely to be confused, delirious, agitated, and may experience hallucinations seen in delirium tremens. This disorder is easily reversible when treated quickly with thiamine. It is important to note that Wernicke's syndrome is caused by thiamine deficiency and not alcohol toxicity per se. This conclusion is supported by the fact that the syndrome is quickly (within hours or days) and usually completely reversible when treated with thiamine and the syndrome exists in nonalcoholic patients who have a thiamine deficiency.

Korsakoff's Psychosis results from damage to areas of the brain associated with memory function and is often associated with damage to peripheral nerve tissue as well. This disease is caused, in part, by vitamin B1 deficiencies. Severe loss of short-term memory, the consequent fabrication of stories to fill in the gaps termed "confabulation," and hallucinations are hallmark signs of this disease. The affected individual usually remembers distant events but is confused regarding present or recent happenings such as where she is, why she is there, what she just ate or who may be sitting next to her. The memory impairment is greatly out of pro-

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Note: In animal studies, a similar syndrome can be induced by a thiamine-deficient diet alone without alcohol and treated successfully by vitamins.

Supplementary Reading: "Severe Brain Dysfunction: Alcoholic Korsakoff's Syndrome" by Marlene Oscar Berman in Alcohol Health and Research World, 1990.

portion to other cognitive dysfunctions. A person with Korsakoff's psychosis cannot process and store new information. Prognostically, Korsakoff's syndrome is unlikely to be reversed. Individuals with this debilitating disease will probably end up in a nursing home or require custodial care.

Sleep Disturbance in Alcoholics Although some say they need to drink in order to sleep, it has been found that alcohol interferes with normal sleep. There are four stages of sleep. Each has characteristic brain-wave patterns and occur in a predictable sequence in non-drugged, healthy individuals. Alcohol depresses REM (dreaming) sleep and results in more awakening during a night. This fragmentation of sleep and lack of REM sleep in chronic alcoholics is a serious problem since there is little or no recovery value in this type of sleep. This poor sleep makes people want to sleep longer in the morning and during the day which adds to the stresses of life. When alcohol is withdrawn from the alcoholic, there is a rebound of dreaming. Often there are nightmares because dreaming is so intensive. Increased dreaming can last more than a week before subsiding.

Liver-Brain Effects

While some of the CNS malfunctions in an alcoholic result from direct adverse effects of alcohol on the brain, others reflect the presence of a damaged liver. The CNS can be adversely affected by liver

Supplementary Reading: "Liver-Brain Relation in Alcoholics" by Arria, et. al., in Alcohol, Health Research World, 1990.

disease. Located beneath the diaphragm in the abdominal cavity, the liver acts as a detoxification center by removing toxic substances. It is well documented that alcohol abuse can produce a range of liver injuries including fatty liver, alcoholic hepatitis, and alcoholic cirrhosis. When the liver is diseased, its ability to metabolize, digest, and detoxify is compromised. Toxins, such as ammonia, remaining in a person with a diseased liver can disrupt normal brain functioning. This conclusion is supported by research comparing cirrhotic alcoholics and nonalcoholics, groups of alcoholics with differing degrees of liver damage, alcoholics before and after liver transplantation, and the correlation between biochemical measures of liver function and damage to neurocognitive test performance. These results imply that effective treat-ment of alcoholic liver disease should improve the CNS functioning of alcoholics.

It is estimated that in the United States there are approximately 10 to 13 million people in various stages of alcoholism. No segment of society is immune from alcoholism (Mello and Mendelson, 1985). Unfortunately, the epidemiological findings show that American Indians are at higher risk of alcoholism than other groups. In fact, American Indians have the highest incidence of alcohol problems among all U.S. groups.

Earlier in this unit the importance of cultural relevance was discussed regarding the prospect of successful education. The same consideration is necessary for successful treatment of alcohol abuse. Here again, the Medicine Circle plays an important role. Not just the physical body is devastated by alcohol. A person's mental, emotional and spiritual well-being are also damaged. Because

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of the typical American Indian perspective of wholeness, all these aspects must be involved in culturally relevant treatment. There is a movement among American Indians to take charge of the treatment and healing of their own communities and to incorporate religious ceremonies and traditional healing practices like the vision quest of the young hunter in the "Legend of the Flute".

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Discussion: Is there a proper place for alcohol in society? When or how can it have a place in the Medicine Circle?

Activity: Create a mind-map of the central nervous system. Contrast and compare it with the mind-map created at the beginning of the unit.

GLOSSARY

THE CENTRAL NERVOUS SYSTEM AND ALCOHOL USE

Acetaldehyde	A toxic chemical produced by the liver in the intermediate steps of alcohol metabolism. It is broken down to acetate, water, and carbon dioxide by acetaldehyde dehydrogenase.
Action Potential	A wave of electrical impulses traveling through a neuron to the end of the axon.
Aldehyde	An enzyme that creates acetate out of the highly toxic acetaldehyde.
Amino Acids	The building blocks of which proteins are constructed and the end-products of protein digestion.
Association Cortex	Area of the cerebral cortex associated with complex processes such as thought and language.
Axon	A process of a neuron that conducts impulses away from the cell body. Axons are usually long and straight, and most end in synapses in the central nervous system or ganglia or in effector organs (e.g., motor neurons).
Blood-Brain Barrier	A layer of tissue that surrounds the brain and separates it from the rest of the body. It works to prevent toxins that may be in the blood from entering the brain and possibly causing damage.
Bouton	Bulblike expansions at the tips of axons that come into synaptic contact with the cell bodies and dendrites of other neurons.
Central Nervous System	The nerve cells in the spinal cord and brain.

Cerebral Cortex	Outer layer of the brain covering the two brain hemispheres. It represents the most recent evolutionary development of the nervous system.
Cerebrospinal Fluid	A clear liquid that has similar properties to blood, but without any blood cells in it. It functions to protect, buffer, and fuel the brain. It is squeezed out of the blood vessels in the area of the brain and circulates around the brain.
Dendrite	A branched process of a neuron that conducts impulses to the cell body. There are usually several to a cell. They form synaptic connections with other neurons.
Dopamine	A neurotransmitter that is involved in motor activity and the rewarding effects of certain drugs.
Dopamine Synapses	Connections between individual nerves that rely on the neurotransmitter dopamine as a signal.
Electro-encephalogram	A tracing on an electroencephalograph - an instrument for recording electrical activity of the brain.
Enzyme	A protein that accelerates a chemical reaction but which itself does not undergo a net change.
GABA	The amino acid gamma-aminobutyric acid, the major inhibitory neurotransmitter in the brain.
Glucose	A sugar. Glucose is the most important carbohydrate in body metabolism. It is formed during digestion from the hydrolysis of di- and polysaccharides, esp. starch, and absorbed from the intestines into the blood of the portal vein. In its passage through the liver, excess glucose in converted into glycogen.

Glutamate	Salt of glutamic acid.
Homunculus	A topigraphical map of the body that is found in several areas of the brain, each area exaggerating the parts of the body for which it is particularly responsible.
Hypothalamus	A region at the base of the brain that is involved with basic behavioral and physiological functions. It is the center for many of the endocrine functions of the body.
Innate Tolerance	A term used to describe differences in initial sensitivity to alcohol.
Ion	An atomic particle carrying an electric charge.
Lipid	Any one of a group of fats or fatlike substances characterized by their insolubility in water and solubility in fat solvents such as alcohol.
Metabolite	Any product of metabolism.
Motor Cortex	Area of the cerebral cortex that is involved in controlling motor activity (physical movements) of the body.
Motor Neurons	The nerves from the brain that control body movement. They carry impulses that initiate muscle contraction.
Nervous System	An extensive, complicated organization of structures by which the internal reactions of the individual are correlated and integrated and by which the adjustments to environment are controlled. It is separated arbitrarily into two large divisions: 1) The Central Nervous System, and 2)The Peripheral Nervous System.
Neuron	A nerve cell, the structural and functional unit of the nervous system. A neuron consists of a cell body and its processes, an axon, and one or more dendrites. Neurons function in initiation and conduction of impulses.

Neurotransmitter	A substance such as norepinephrine or dopamine that is released when the axon terminal of a presynaptic neuron is excited. The substance then travels across the synapse to act on the target cell to either inhibit or excite it.
Norepinephrine	A neurotransmitter with various regulatory functions, important in arousal and learning.
Peripheral Nervous System	The nerves, ganglia and end organs which connect the Central Nervous System with other parts of the body.
Receptor	A protein in the wall of a neuron or other cells that recognizes and binds neurotransmitters or other chemical messengers.
Serotonin	A neurotransmitter that affects mood, consummatory behaviors, and the development of tolerance to alcohol.
Somatosensory Cortex	Area of the cerebral cortex that is involved in sensory input for the senses.
Synapse	A microscopic gap separating adjacent neurons.

BIBLIOGRAPHIC REFERENCES
CENTRAL NERVOUS SYSTEM AND ALCOHOL USE

Arria, A., Tarter, R. and Van Thiel, D. "Liver-Brain Relation in Alcoholics" in Alcohol, Health and Research World. 14(2), 1990.

Berman, Marlene Oscar. "Severe Brain Dysfunction: Alcohol Korsakoff's Syndrome" in Alcohol, Health and Research World 14(2), 1990.

Bloom, Floyd E. and Lazerson, Arlyne. Brain, Mind, and Behavior. Second edition. New York: W.H. Freeman and Company, 1988.

Caduto, Michael J. and Bruchac, Joseph. Keepers of the Earth: Native American Stories and Environmental Activities for Children. Golden, Colorado: Fulcrum, Inc., 1989.

Campbell, Neil A. Biology. Menlo Park, CA: Benjamin/Cummings Publishing Co. Inc., 1987.

Carlson, Neil R. Physiology of Behavior. Third edition. Massachusetts: Allyn and Bacon, Inc., 1986.

Carpenter, Malcolm B. Human Neuroanatomy. Baltimore: Williams and Wilkins Company, 1976.

Charness, Michael. "Alcohol and the Brain" in Alcohol, Health and Research World, 14(2), 1990.

Crow Dog, Henry. "The Legend of the Flute" in American Indian Myths and Legends. Selected and edited by Richard Erdoes and Alfonso Ortiz. New York: Pantheon Books, 1984.

Fishman, Ross. The Encyclopedia of Psychoactive Drugs: Alcohol and Alcoholism. Solomon H. Snyder editor. Chelsea House Publishers, 1987.

Gray, Henry. Anatomy of the Human Body, ed. Charles Mayo Goss. Philadelphia: Lea and Febiger, reprinted May, 1969.

Grof, Stanislav. Beyond the Brain: Birth, Death and Transcendence in Psychotherapy. Albany: State University of New York Press, 1985.

Guyton, A.C. Human Physiology and Mechanisms of Disease. Fourth edition. Philadelphia: W.B. Saunders Company, 1987.

Harris, A. and Buck, K. "The Process of Alcohol Tolerance and Dependence" in Alcohol, Health and Research World, 14(2), 1990.

Kinney, Jean and Leaton, Gwen. Loosening the Grip: A Handbook of Alcohol Information. St. Louis: Times Mirror/Mosby College Publishing, 1987.

Kuffler, S.W., Nicholls, J.G., Martin, A.R. "Ionic Basis of Resting and Action Potentials" from From Neuron to Neuron. Second edition. Sunderland, MA: Sinauer Associates Inc. Publishers, 1984.

BIBLIOGRAPHIC REFERENCES
THE CENTRAL NERVOUS SYSTEM AND ALCOHOL USE

Mello, N.H. and Mendelson, J.H. Alcohol Use and Abuse in America. Boston: Little Brown Publishers, 1985.

Milam, James R. and Ketcham, Katherine. "Tolerance" from Under The Influence: A Guide to the Myths and Realities of Alcoholism. Seattle: Madrona Publishers, Inc., 1981.

Milkman, Harvey B. and Sunderwirth, Stanley G. "Biochemistry: The Gateway to Excess" from Craving for Ecstasy: The Consciousness and Chemistry of Escape. D.C. Heath and Company, 1987.

National Institute on Alcohol Abuse and Alcoholism. "Alcohol and Cognition" in Alcohol Alert. Rockville, MD: U.S. Department of Health and Human Services, Public Health Service, Alcohol, Drug Abuse, and Mental Health Administration, No. 4, May 1989.

O'Connor, S., Hesselbrock, V. and Bauer, L. "The Nervous System and the Predisposition to Alcohol" in Alcohol, Health and Research World, 14(2), 1990.

Pearce, Joseph C.Magical Child: Rediscovering Nature's Plan For Our Children. Bantam Books, 1977.

Petrakis, Peter L. "Neurochemical and Neurophysi-ological Variations" from Alcoholism: An Inherited Disease. Written for National Institute on Alcohol Abuse & Alcoholism. DHHS Publication No. (ADM) 85 - 1426, 1985.

Rose, R.M and Barrett, J.E. eds. "Overview of the Concept of Tolerance" from Alcoholism: Origins and Outcomes. New York: Raven Press, 1988.

Shields, Lora Mangum. An Overview of Human Biology: Self-Paced Alternatives, Narrative for Test Banks Reverse Multiple Choice Questions. Dubuque: Kendall/Hunt Publishing Company, 1989.

Somjen, G. Neurophiology - The Essentials; the Cycle of Sleeping and Waking. New York: Williams and Wilkins, 1983.

Spence, Alexander P. Basic Human Anatomy. Second edition. Menlo Park, CA: Benjamin/Cummings Publishing Company Inc., 1982.

Tabakoff, B., Hoffman, P. and Peterson, R. "Advances in Neurochemistry: A Leading Edge of Alcohol Research" in Alcohol, Health and Research World 14(2), 1990.

Thompson, Richard F. Introduction to Physiological Psychology. New York: Harper and Row, 1975.

Unit Handouts/Overheads

Overhead 1	CNS Mind Map
Overhead 2	Cynthia's Central Nervous System
Overhead 3/ Handout 1	One of Cynthia's Neurons
Overhead 4/ Handout 2	Cynthia's Neuronal Communication
Overhead 5	Close up of One of Cynthia's Neurons
Overhead 6/ Handout 3	Action Potential
Overhead 7/ Handout 4	Synaptic Transmission
Overhead 8/ Handout 5	Re-uptake
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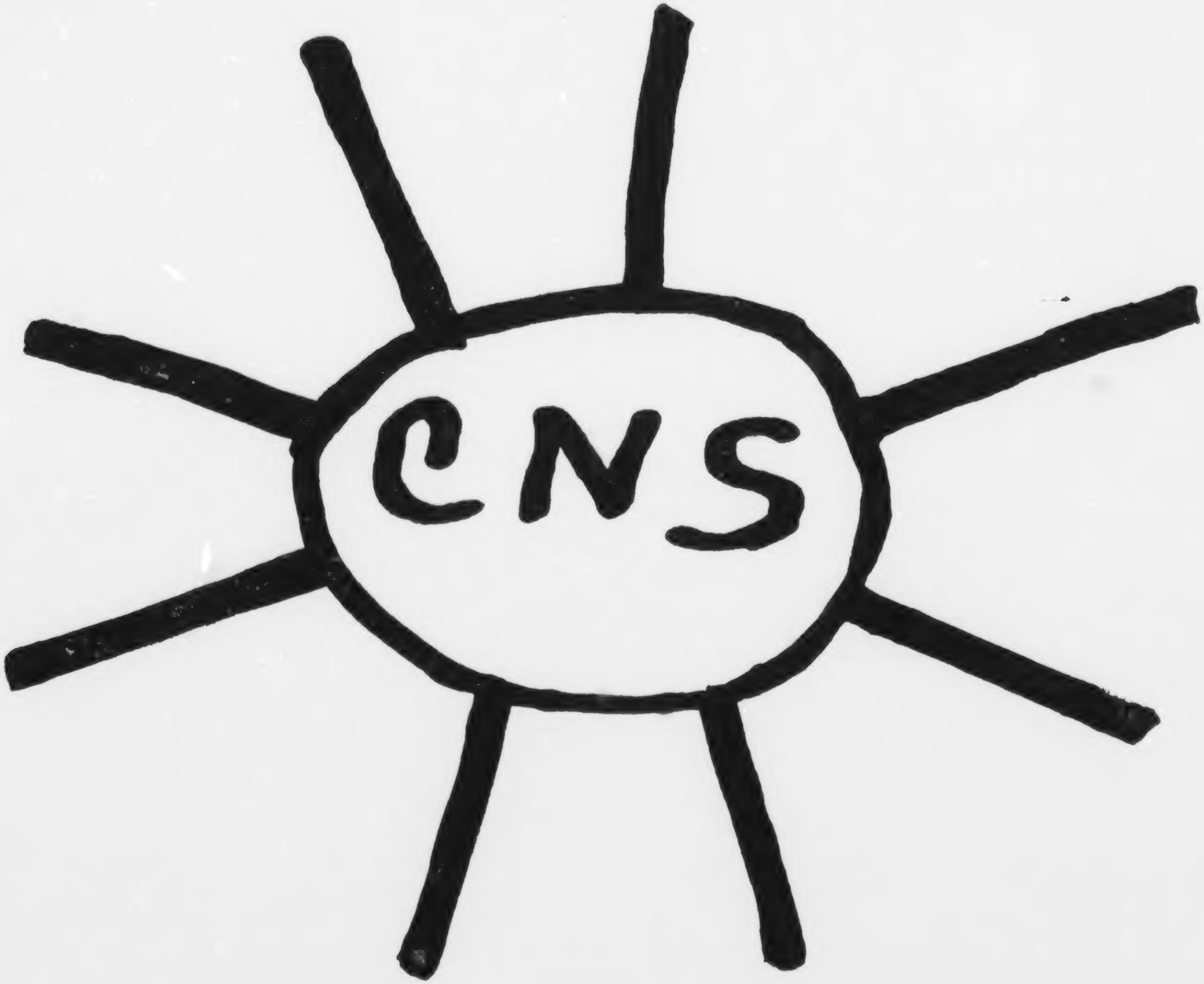
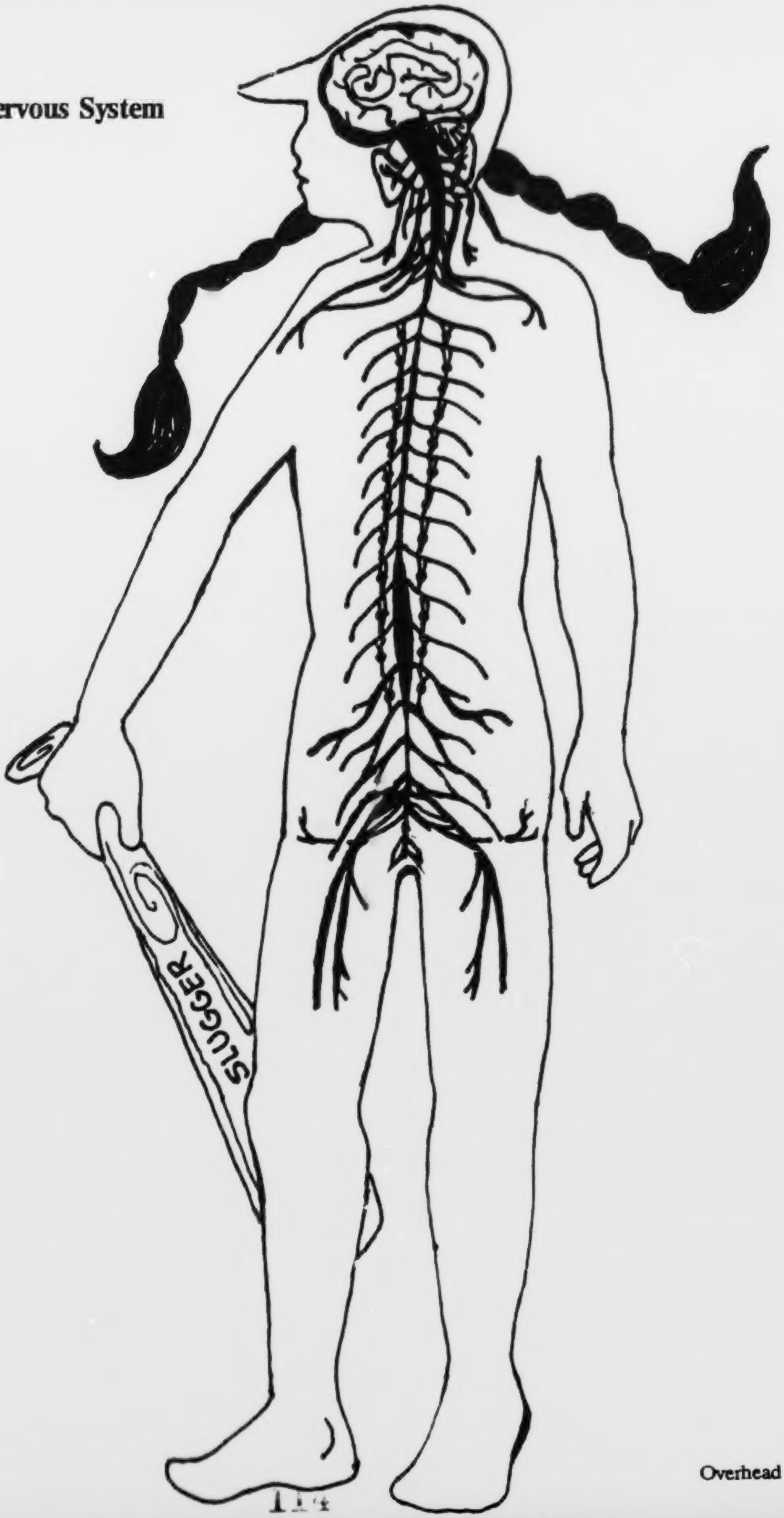
Overhead 14	Polarized Vision of an Alcoholic
Overhead 15	100 Meters/Second
Overhead 16	An Alcoholic's Distorted Self-Image
Overhead 17/ Handout 11	Cynthia's Cerebral Cortex
Overhead 18/ Handout 12	Homunculus



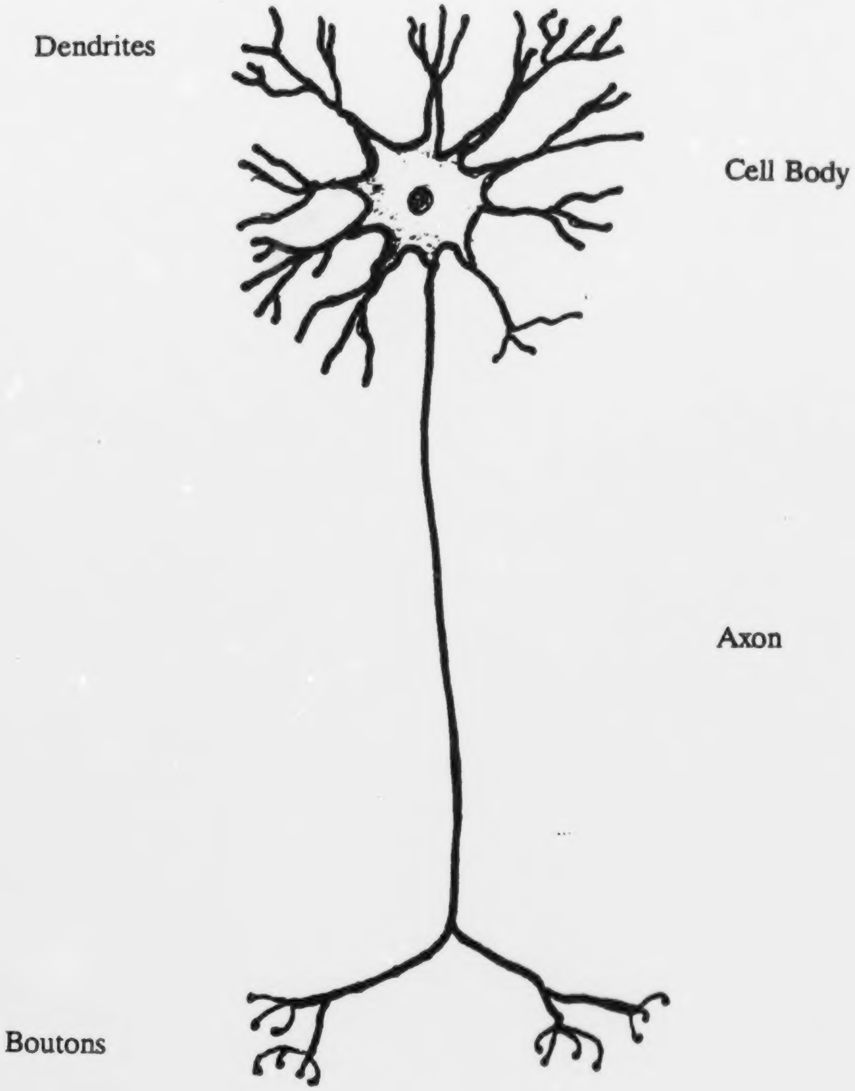
Overhead 1

Cynthia's Central Nervous System



Overhead 2

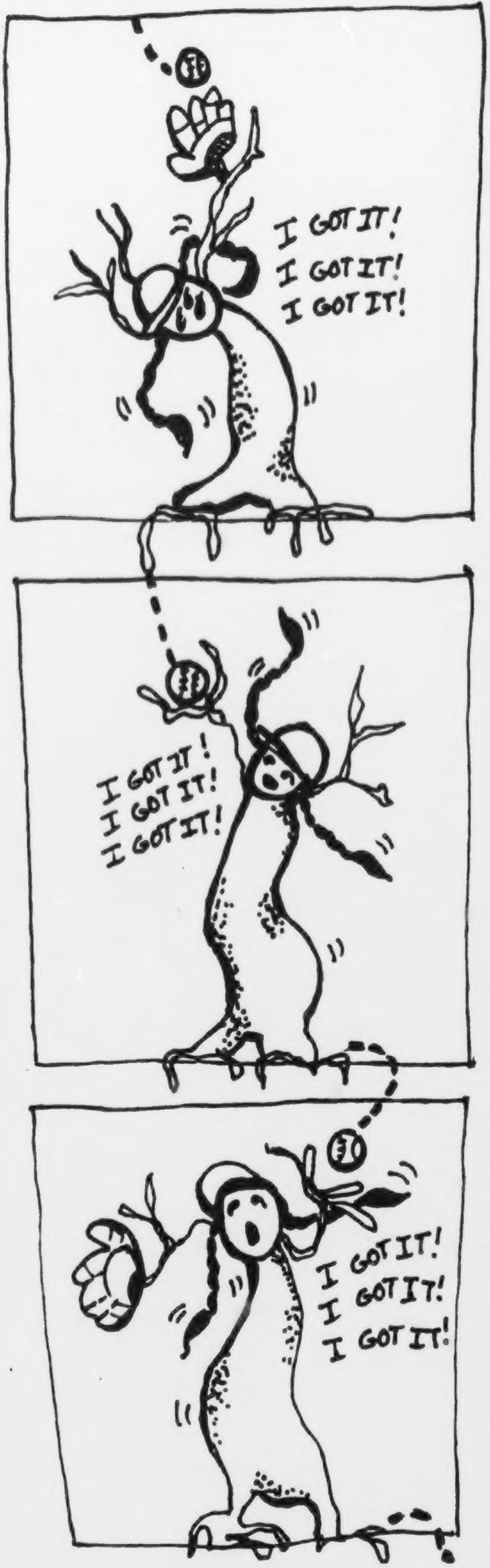
One of Cynthia's Neurons


Dendrites
Cell Body
Axon
Boutons

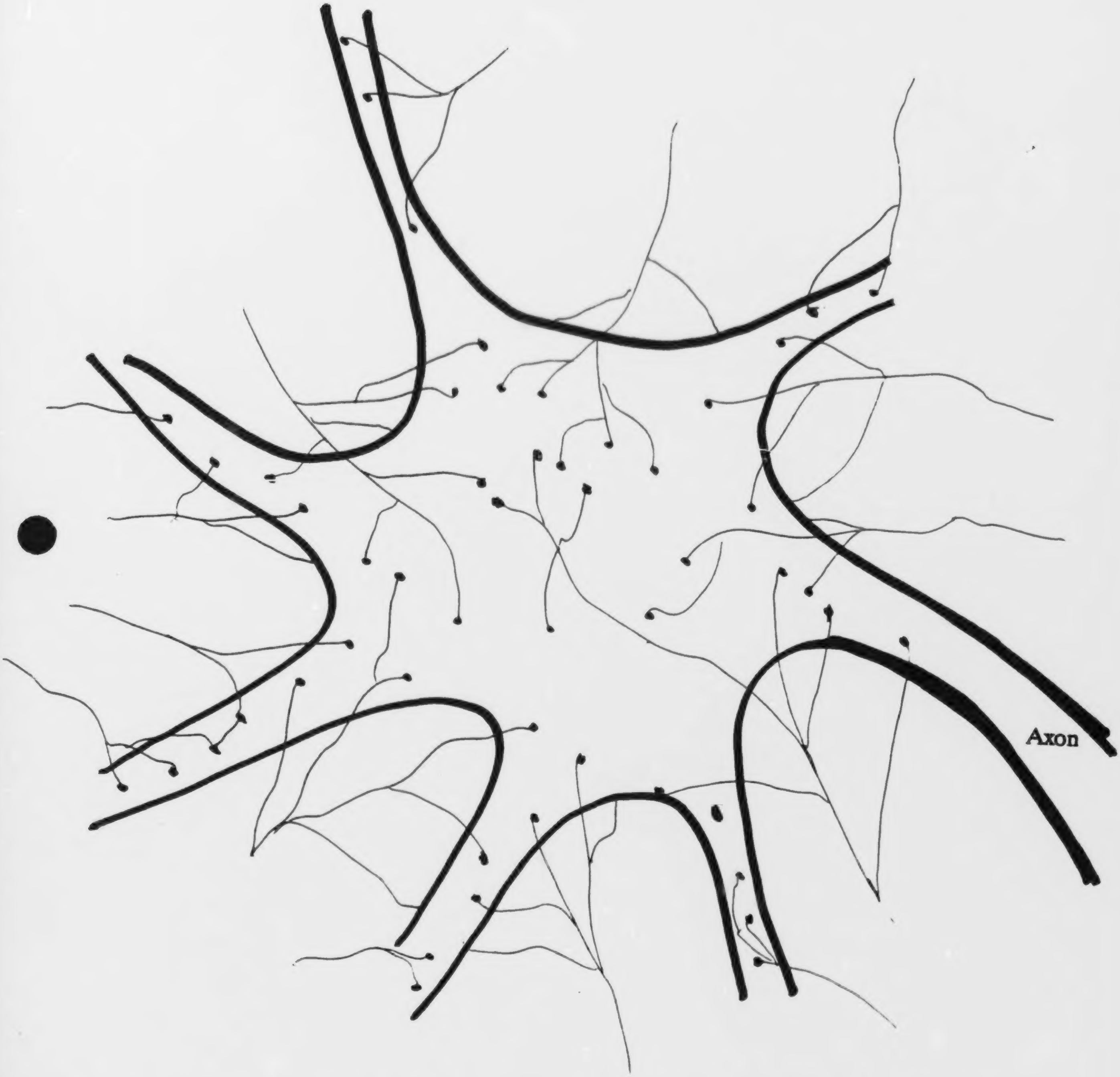
Overhead 3/Handout 1

Cynthia's Neuronal Communication

Information travels from one neuron to another through neurotransmitters. These chemicals are released from the boutons at the end of the axon into the synapse, the space between the bouton and the dendrite or cell body of the next neuron.


I GOT IT!
I GOT IT!
I GOT IT!
I GOT IT!
I GOT IT!
I GOT IT!
I GOT IT!
I GOT IT!
I GOT IT!

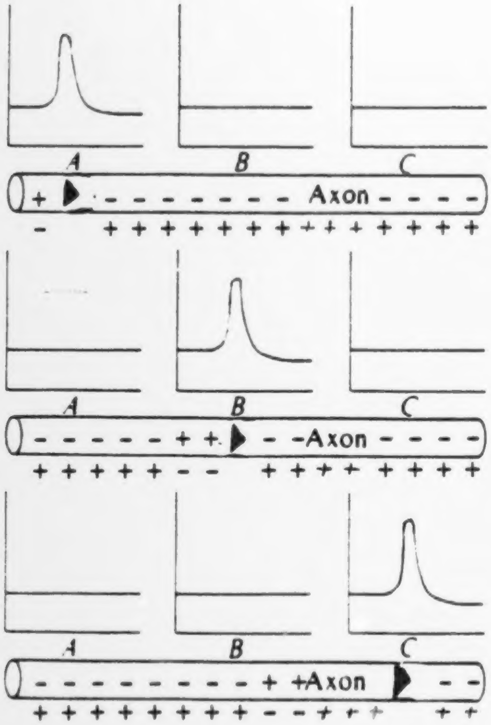
Close Up of One of Cynthia's Neurons



The terminal endings of neurons interact with the cell body and dendrites of another neuron in order to pass information (neurotransmitters) along.

Overhead 5

ACTION POTENTIAL


A
B
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A
B
C
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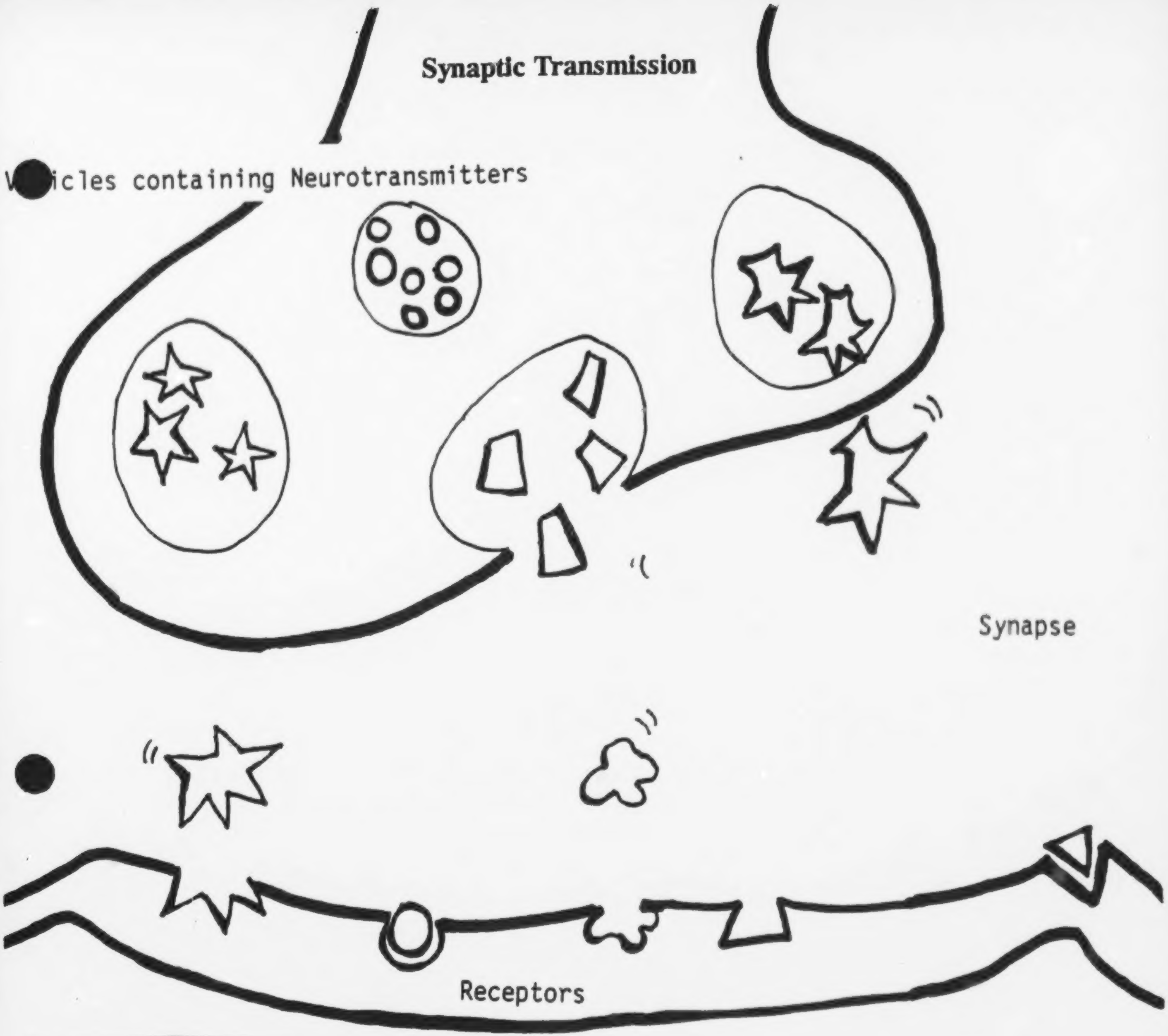
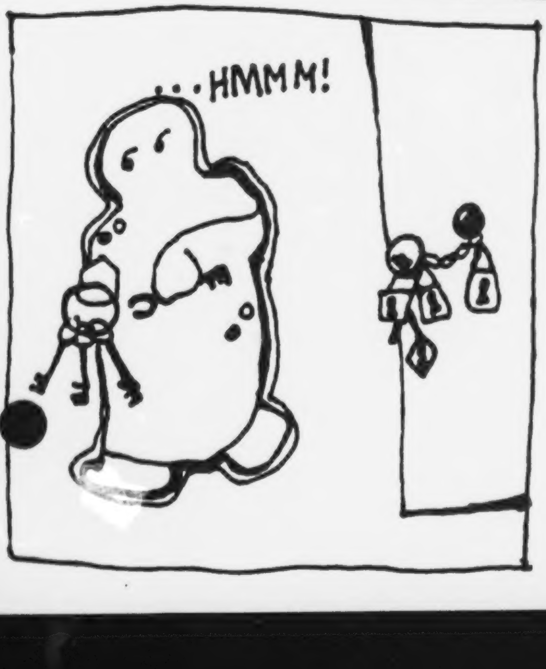
An action potential is a brief change in the electrical potential of a neuron. The change starts at the dendrite end of the neuron and moves through the cell to the boutons at the end of the axon.

Synaptic Transmission

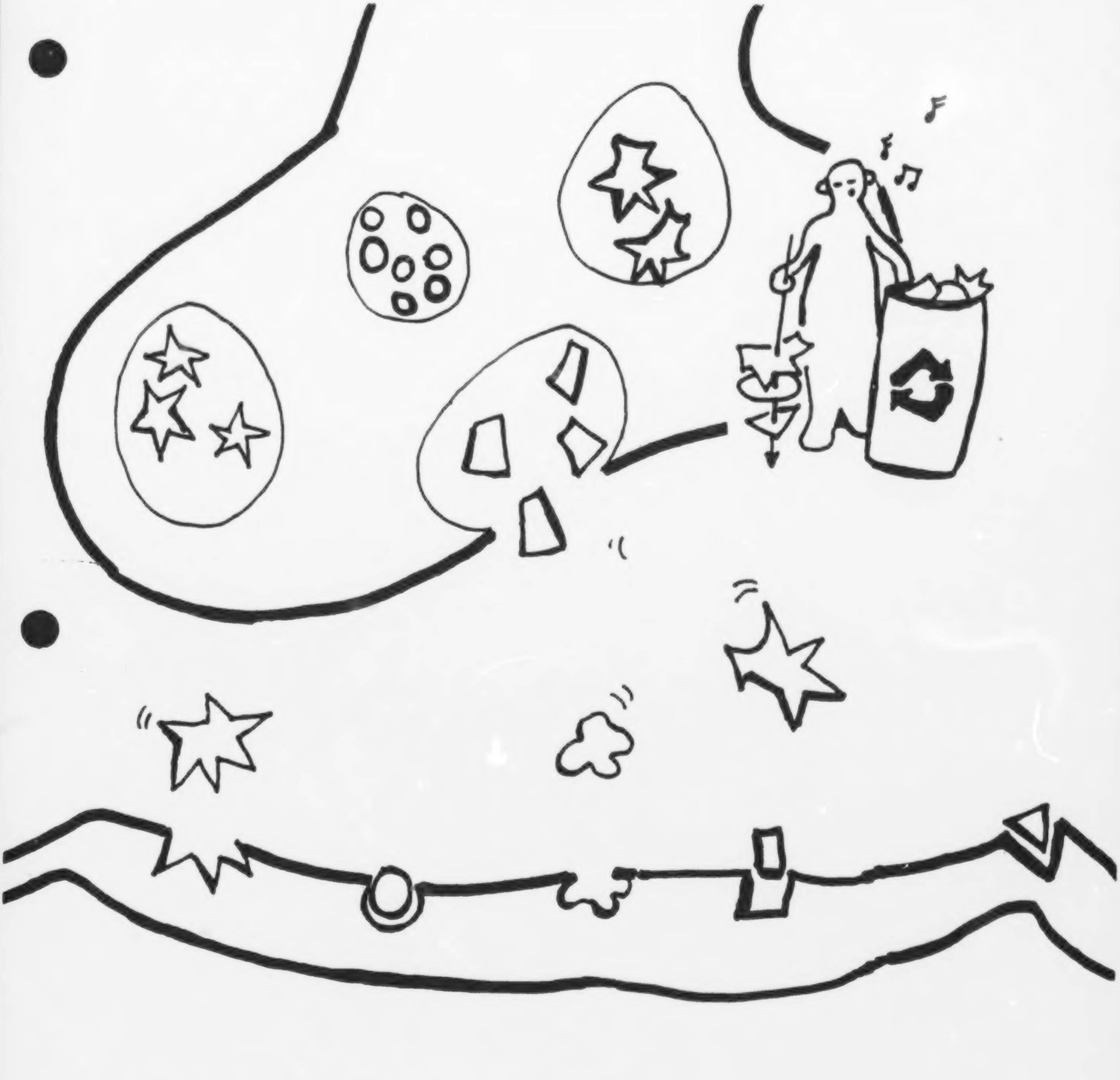

Vesicles containing Neurotransmitters
Synapse
Receptors



There are a number of neurotransmitters in the brain. Neurotransmitters can open ion channels only if they fit the receptor, like a key in a lock.

Overhead 7/Handout 4

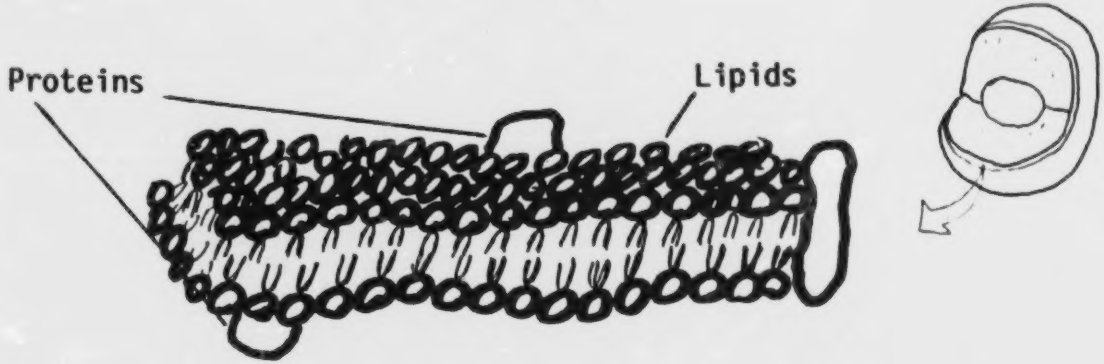
Reuptake



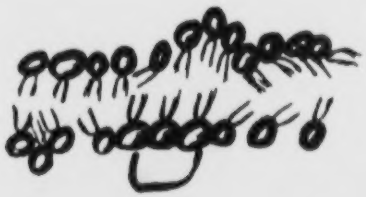
The effects of neurotransmitters are terminated by re-uptake. This process is simply the removal of transmitter substances from the synapse. The cell membrane surrounding the bouton contains a pump-like mechanism that returns the transmitter from the synapse directly into the presynaptic bouton giving the receiving cell only a brief exposure to the transmitter.

Overhead 8/Handout 5

Cell Membrane

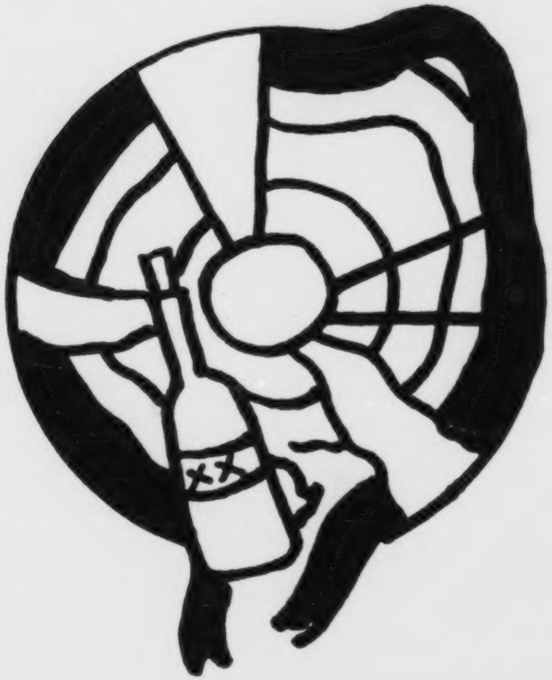


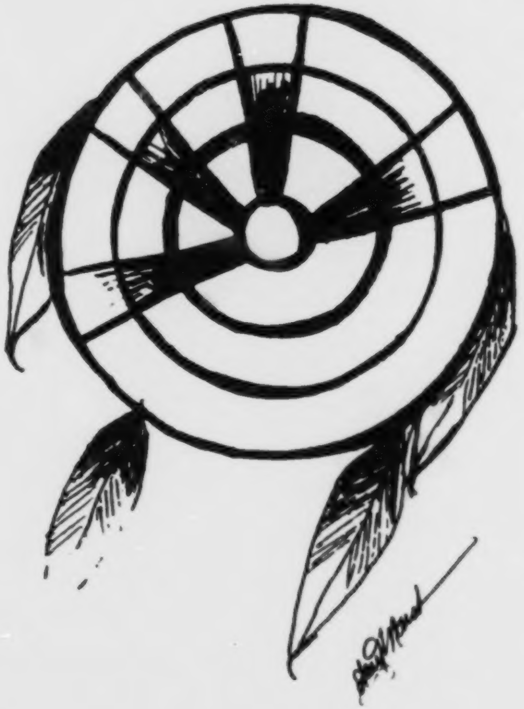
Each cell is surrounded by a cell membrane which is selectively permeable. The membrane is composed of proteins floating in a fluid bilayer (two layers back-to-back) of lipid. Membranes form the outermost layer of most animal cells, including neurons. Materials that enter or leave the cell must pass through this membrane.

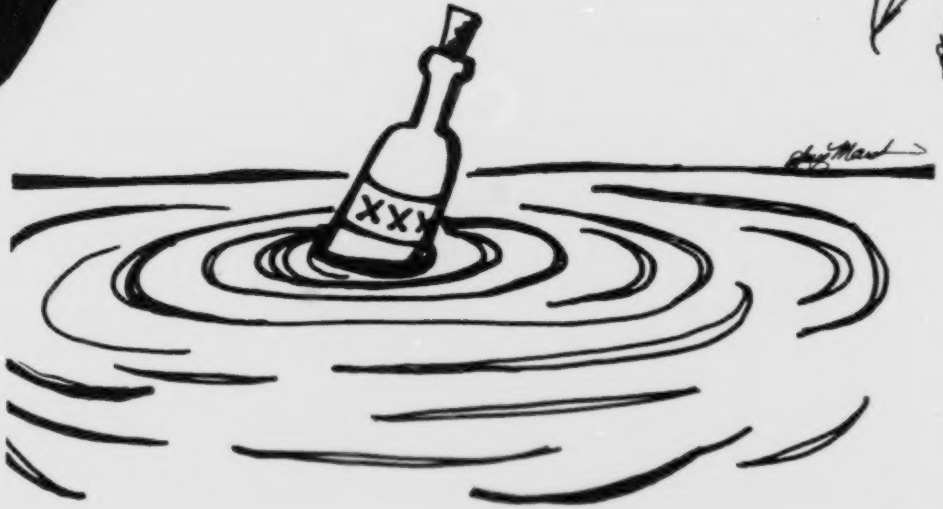


Alcohol appears to cause cell membranes to become less organized.

Out Of Balance

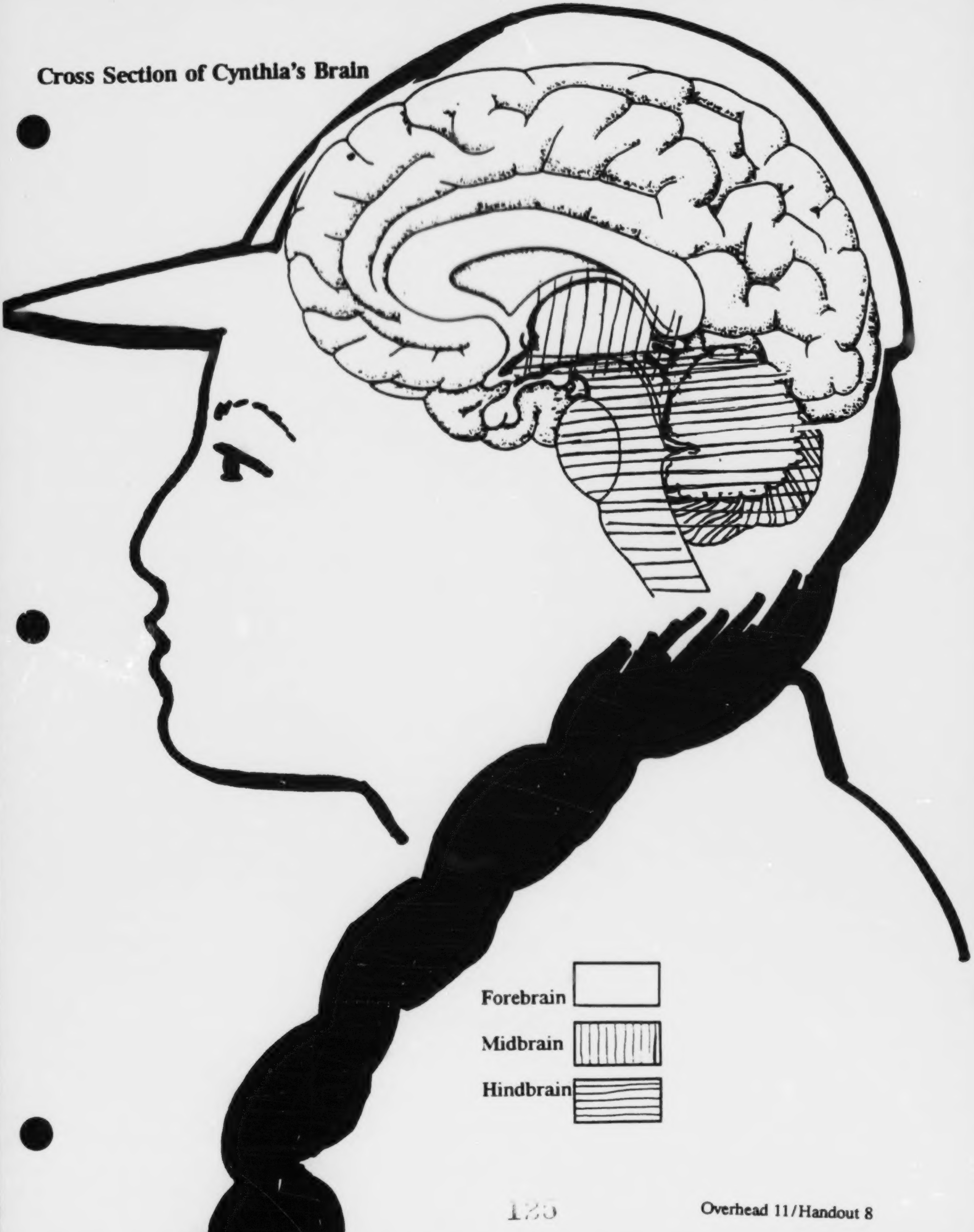




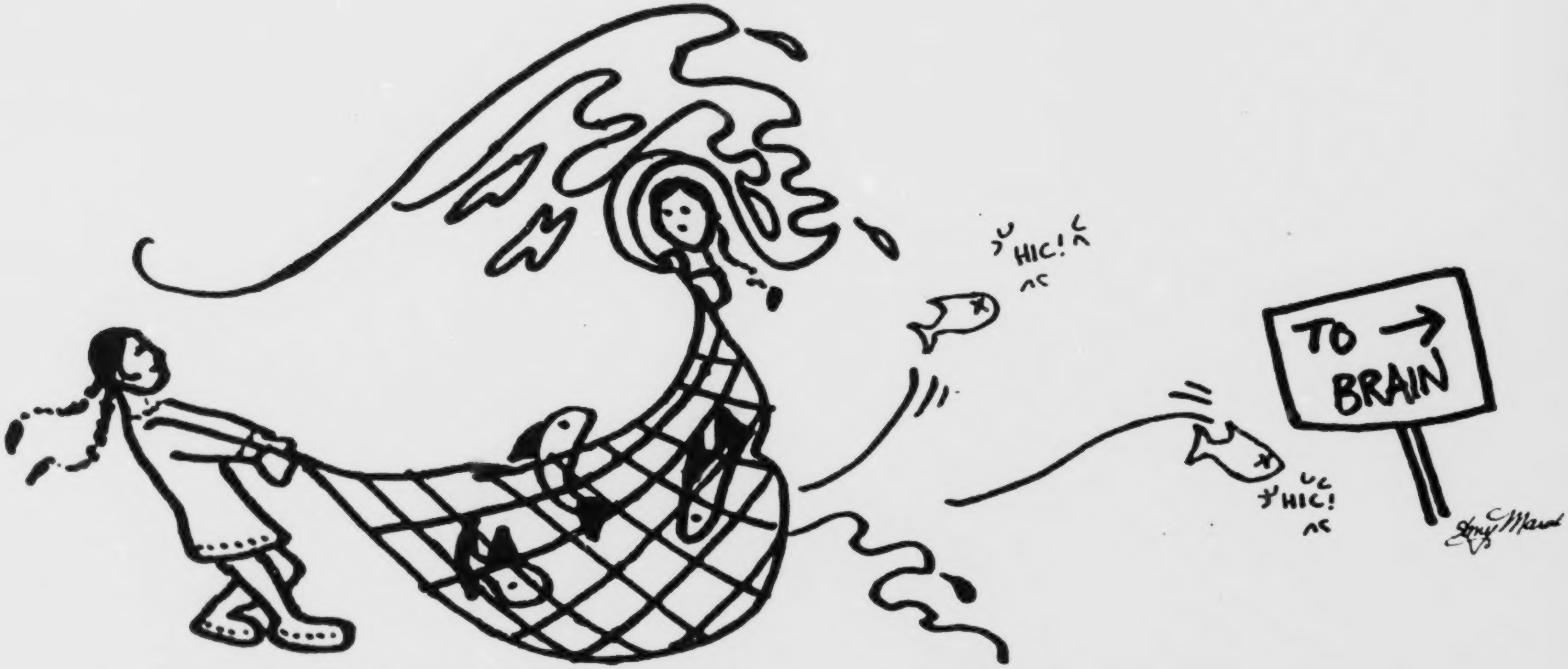


Overhead 10/Handout 7

Cross Section of Cynthia's Brain

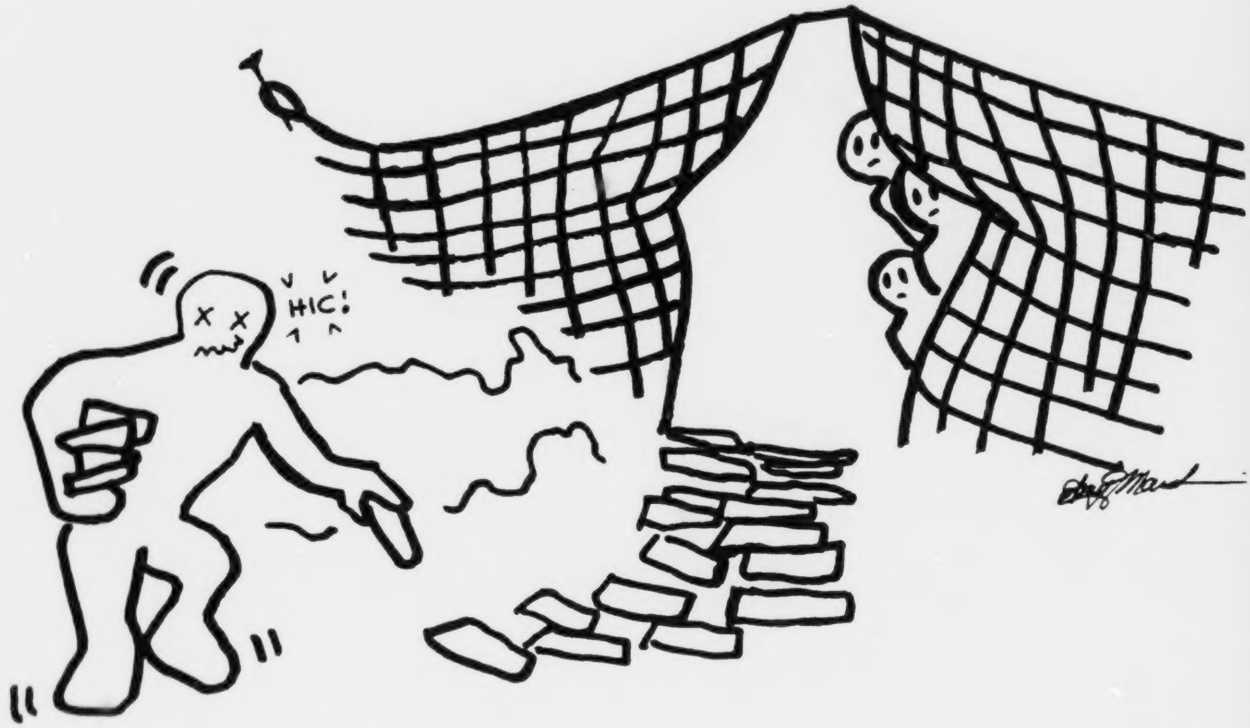

Forebrain ☐
Midbrain ▥
Hindbrain ▤

THE BLOOD-BRAIN BARRIER


HIC!
TO → BRAIN
HIC!
Amy Mare

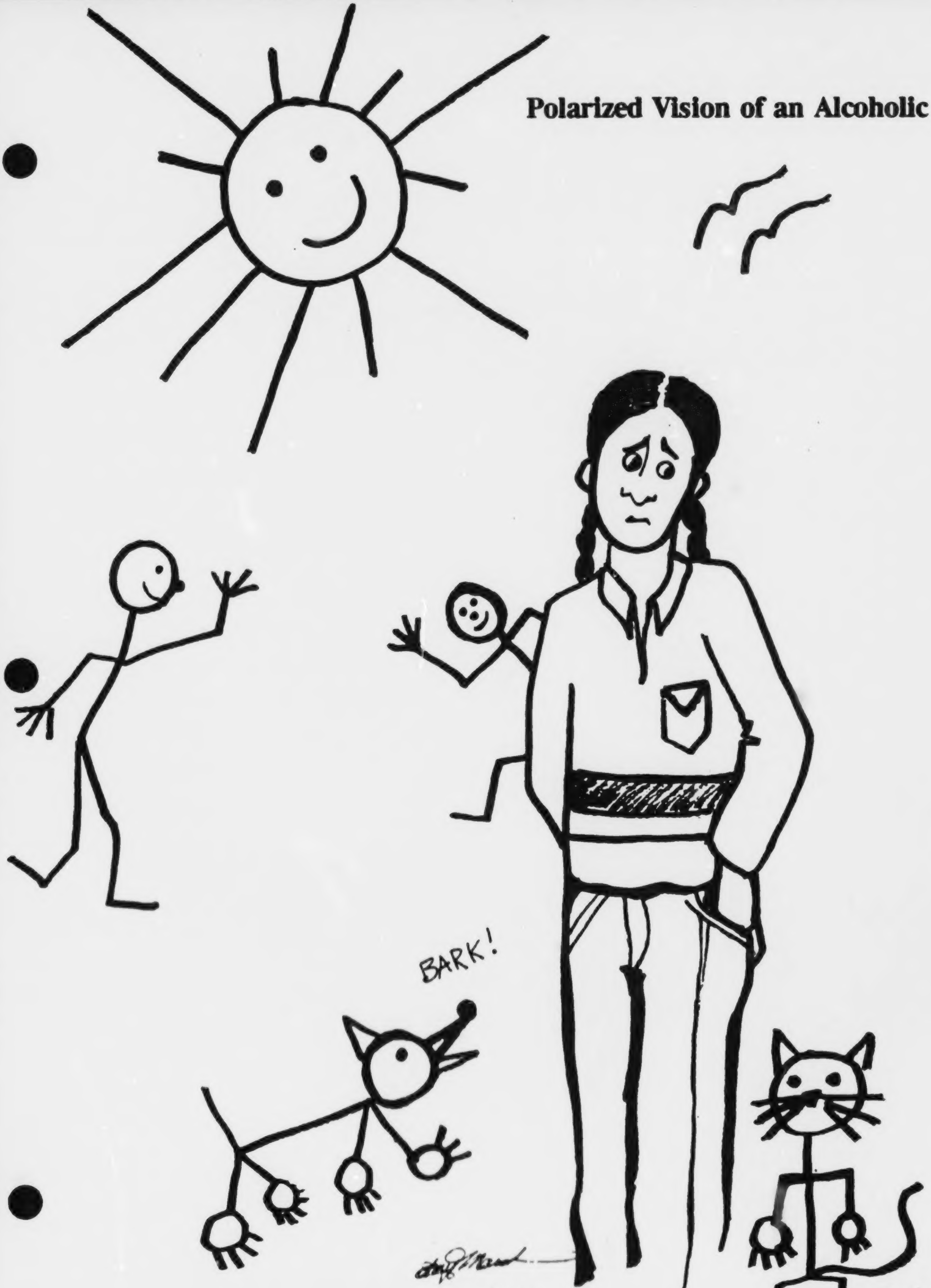
Overhead 12/Handout 9

Acetaldehyde tends to leave the blood-brain barrier open.

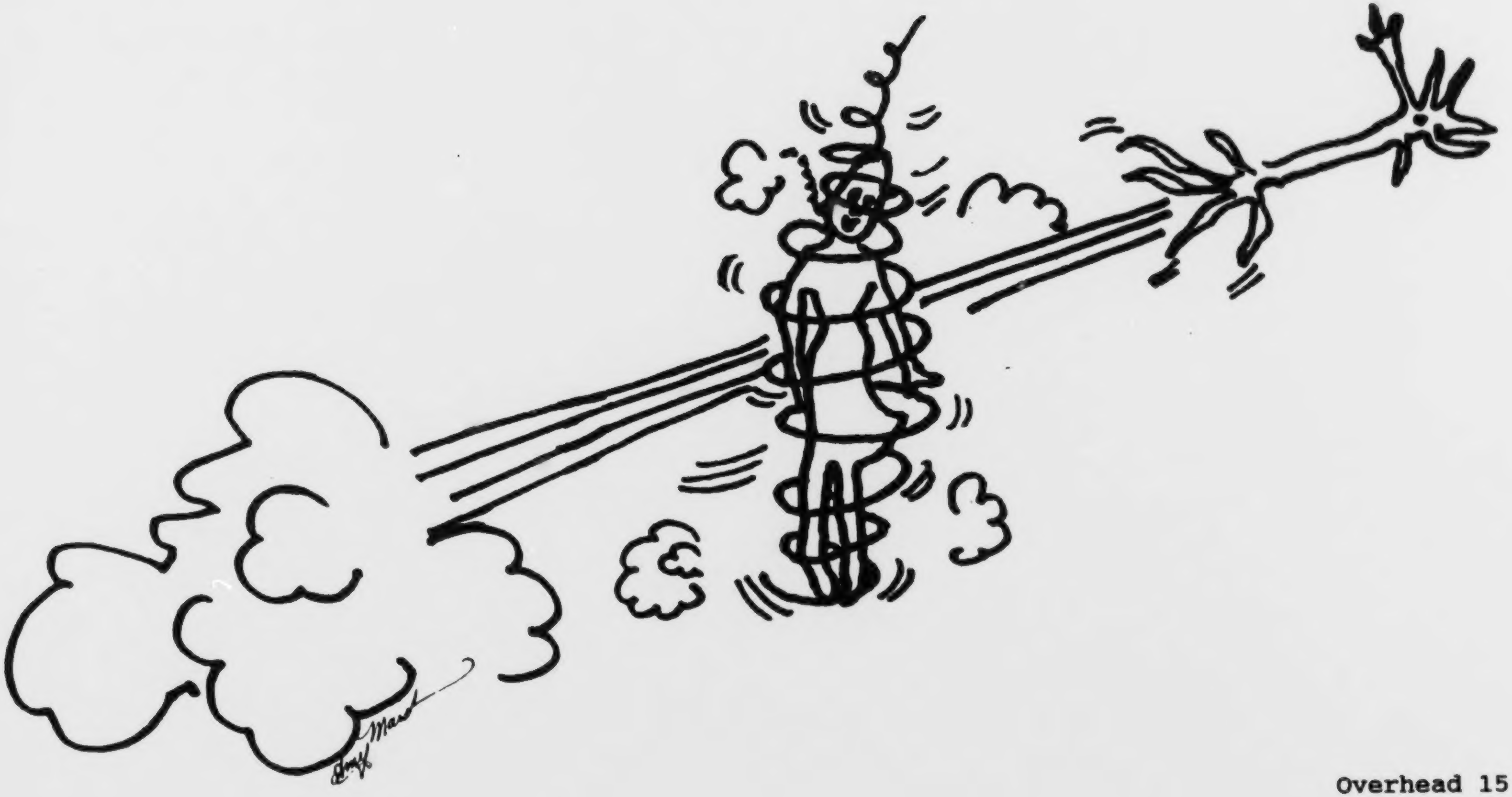


Overhead 13/Handout 10

Polarized Vision of an Alcoholic

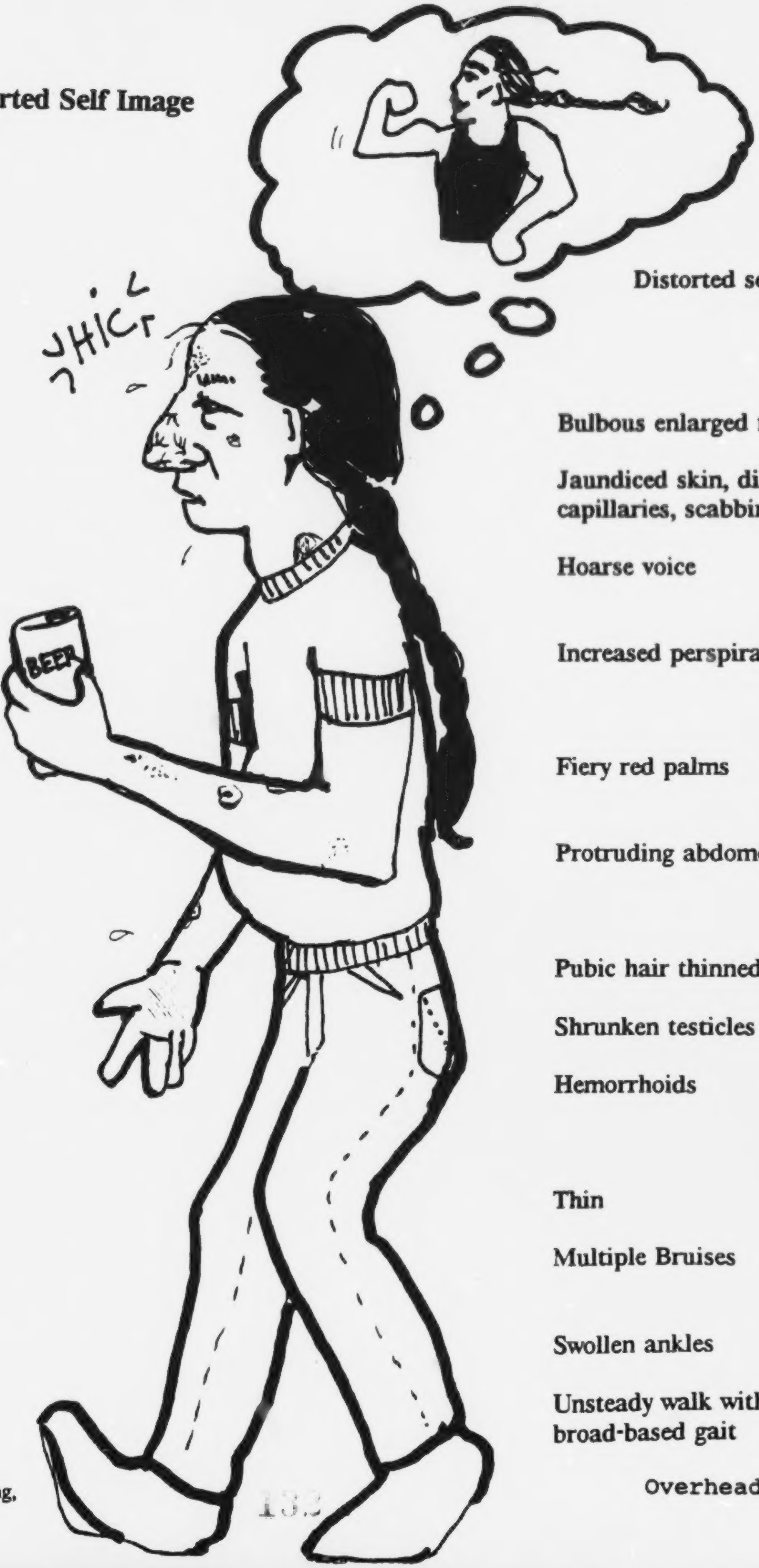


100 METERS/SECOND



Overhead 15

An Alcoholic's Distorted Self Image



Distorted self-image

Bulbous enlarged nose

Jaundiced skin, dilated capillaries, scabbing, pustule

Hoarse voice

Increased perspiration

Fiery red palms

Protruding abdomen

Pubic hair thinned or lost

Shrunken testicles

Hemorrhoids

Thin

Multiple Bruises

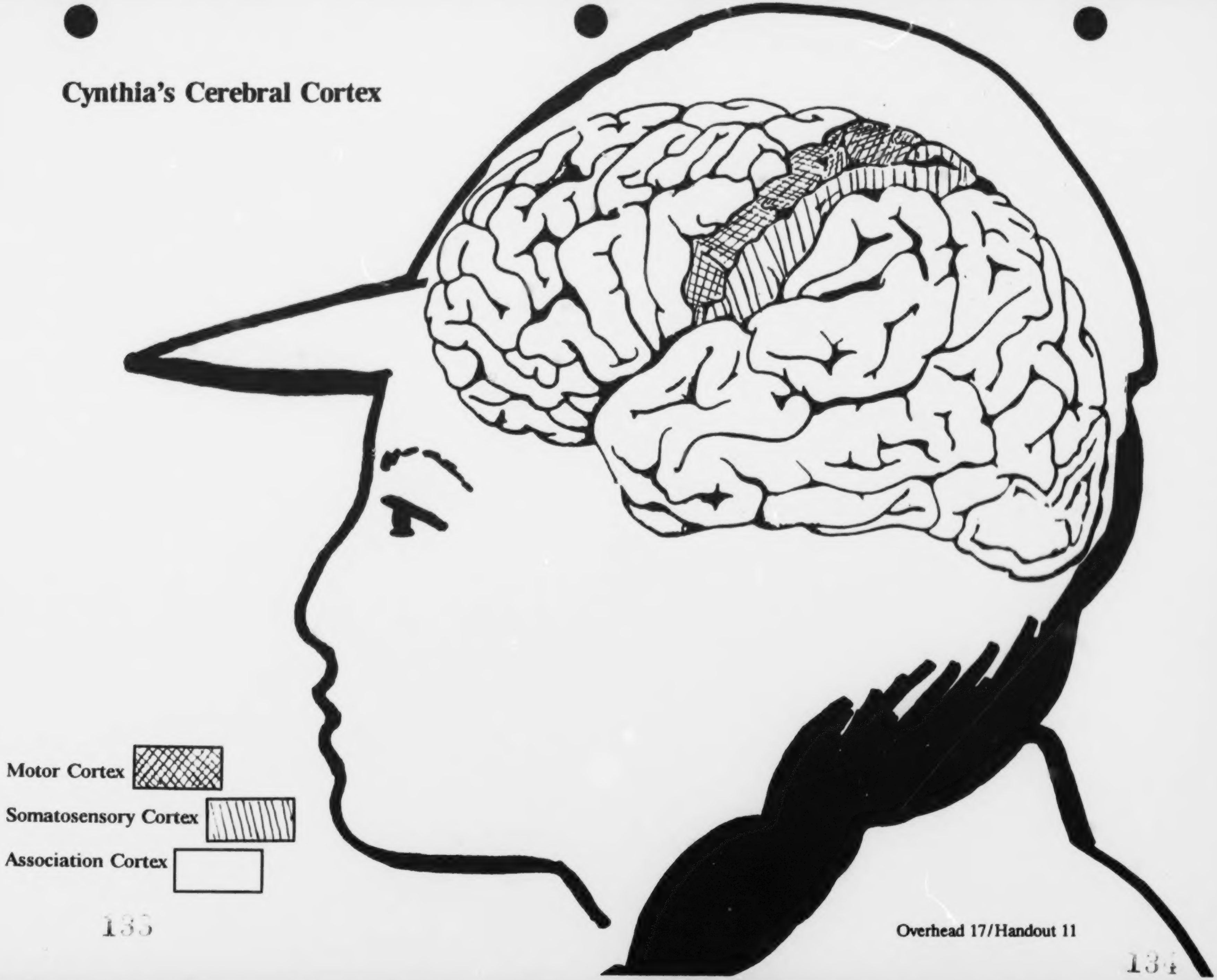
Swollen ankles

Unsteady walk with broad-based gait

Overhead 16

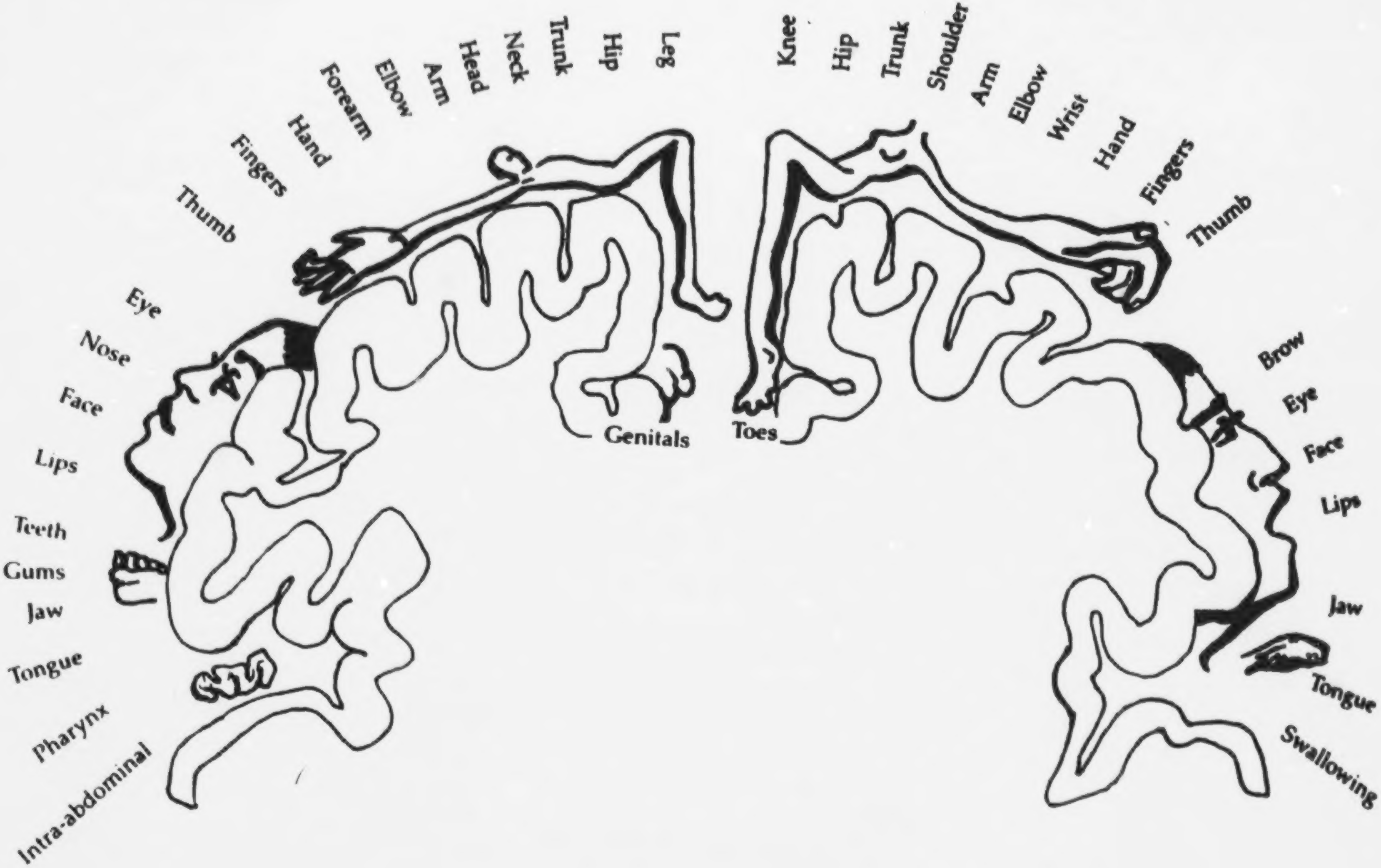
ad[illegible]d from Loosening the Grip: A Handbook of Alcohol Information
by Jean Kinney and Gwen Leaton,
Times Mirror/Mosby College Publishing,
St. Louis, 1987.

Cynthia's Cerebral Cortex


Motor Cortex ▩
Somatosensory Cortex ▥
Association Cortex ☐

Overhead 17/Handout 11

HOMUNCULUS



Intra-abdominal
Pharynx
Tongue
Jaw
Gums
Teeth
Lips
Face
Nose
Eye
Thumb
Fingers
Hand
Forearm
Elbow
Arm
Head
Neck
Trunk
Hip
Leg
Genitals
Toes
Knee
Hip
Trunk
Shoulder
Arm
Elbow
Wrist
Hand
Fingers
Thumb
Brow
Eye
Face
Lips
Jaw
Tongue
Swallowing

Overhead 18/Handout 12

Evaluation Form - Trainer

Name of Unit: ______________________________

Number of Participants: ______________________

Date of Training: ___________________________

Location of Training: _________________________

Instructions: Please complete this form and mail along with participant evaluation forms after the training session.

		strongly disagree		no opinion		strongly agree	comments
1.	The unit was easy to use during the training	1	2	3	4	5	
2.	The unit contains useful and appropriate overheads	1	2	3	4	5	
3.	The unit contains useful and appropriate handouts	1	2	3	4	5	
4.	The unit contains useful and appropriate supplemental readings	1	2	3	4	5	
5.	The content in the unit was easy to understand	1	2	3	4	5	
6.	The suggested activities and discussion issues in the unit were valuable to the training session	1	2	3	4	5	
7.	The questions in the "Participant Booklet" assisted in the overall training	1	2	3	4	5	
8.	The classroom application issues in the "Participant Booklet" were useful in the training	1	2	3	4	5	

9. The unit's strengths are:

(over)

10. Recommended improvements for the unit are:

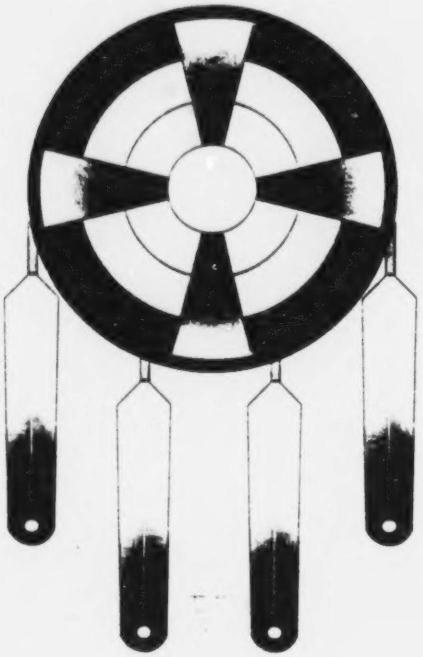
11. Additional Comments:

IMPORTANT: Please return the completed trainer and participant evaluation forms to the address below:

Director, SACAI Program
AISES
1085 14th Street
Suite 1506
Boulder, CO 80302

RC018605

Science of Alcohol Curriculum for American Indians
(SACAI)



Participant Booklet

The Central Nervous System and Alcohol Use

AMERICAN INDIAN
SCIENCE & ENGINEERING SOCIETY

BEST COPY AVAILABLE

Science of Alcohol Curriculum for American Indians:
(SACAI)

The Central Nervous System and Alcohol Use

Participant Booklet

Authors: Cecelia Jacobs
Heather Duffy
John Gilburt, Ph.D.
Wendy Keir, Ph.D.

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American Indian Science and Engineering Society
1085 14th Street, Suite 1506
Boulder, CO 80302

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Preface

People generally learn best and retain more information when it is presented to them in a framework or context which makes cultural and social sense, which is relevant to them. In other words, learning is culturally specific. We retain and use information which reaffirms those things which we have already learned from our families, communities, and cultural and social heritage. If the content of a curriculum is culturally or racially biased, or rooted solely in the history, heritage, and language of a particular group, to the exclusion of others, then those outside of the system become crippled and disadvantaged in the process of learning (Manning Marable, 1990; Baca and Cervantes, 1989; Collier and Hoover, 1987).

SACAI uses the Medicine Circle as means of addressing this issue. Although not all American Indian groups include the specific model of the Medicine Circle, the concepts of wholeness, interconnectedness and balance which it represents are consistent with most American Indian traditional ideals. Although distinctions in the symbol are made with lines, an understanding of interdependence and co-existing realities blurs these distinctions which are artificially imposed by the lines.

The four aspects of the Medicine Circle as studied in SACAI are physical, spiritual, mental and emotional. They are examined as they relate to individuals, families, communities and the world. These aspects can be described as follows:

Physical	the tangible world we perceive with our senses;
Spiritual	the interconnectedness and interdependence of all of nature and the creator;
Mental	the experience of perceiving and processing information;
Emotional	the feelings generated in reaction to perceptions.

Most American Indian cultures are congruent with and reflective of what is being called the new science paradigm. This new framework for science observation includes the understanding that the parts do not reveal the whole; the part is merely a pattern in an inseparable web of relationships. Another aspect of the new paradigm is the perception that everything is dynamic. The focus is on the processes through which structures interact rather than on the structures themselves. The observer is part of the universe which he or she observes and not an objective separate entity. And instead of arranging nature in a hierarchy of building blocks, the new paradigm describes a network of interrelationships in which nothing is more important than anything else. Mankind does not stand at the top of the pyramid of nature charged with "dominion over it", but is instead linked to all the elements of nature as in a web.

In both the new science paradigm and the Medicine Circle, the focus is on relationships and connections. The science of alcohol is studied from the integrative perspective of physical, spiritual, mental and emotional views in conjunction with the values of the new paradigm in order to explore a scientifically sound and culturally relevant understanding of the topic and issues.

Alcohol can be a difficult issue for both teachers and students to pursue. There are important physical, spiritual, mental and emotional components to this topic. Teachers need to address these various aspects from their own personal lives and be aware of their own issues before asking students to consider theirs. SACAI explores ways of doing this.

Teaching the science of alcohol to any group of students can be a delicate situation. American Indian communities, and therefore, American Indian children, suffer more from alcohol abuse than any other group in the United States. Many of them come from alcoholic families and alcoholic communities. In discussing alcoholism, the teacher is often talking about people these students know and love. Given this situation, it is important to realize that the rubric of science will not erase the impact that alcohol has had on their lives. Looking at this concern from the perspective of science gives teachers the opportunity to teach about the effects of alcohol on the physical body. However, the other areas of the Medicine Circle cannot be ignored. And the concentric circles within the Circle representing the family, community and world can all be included in the science of alcohol because all things are related.

No two people perceive the world in exactly the same way, so no two cultural groups describe and experience the world in the same way. These differences are experienced as advantageous only if both are accepted and valued. In teaching the Medicine Circle and the new science paradigm, the current paradigm and formal reductionist science are not scorned; they are built upon, expanded upon and included in a holistic framework. Application of SACAI in the classroom can be effective from this framework. Respect for a variety of points of view, including holism, is a way to share ideal traditional values that have never been incorporated in the formal educational process.

The nervous system is arbitrarily divided into two major parts, the peripheral and the central nervous systems. The peripheral nervous system consists of the nerves of the body that are relays for information to and from the central nervous system. Elements of the central nervous system (CNS) are discussed in this unit in the context of how they function and how they are affected by alcohol.

Alcoholism causes the progressive poisoning and deterioration of the nervous system. Alcohol can be toxic to all cells in the body. The nervous system is exquisitely sensitive and complex, and therefore it can be easily and extensively damaged by large quantities of alcohol. The CNS affects thoughts, feelings, and behavior, as well as every other system in the body. The damage done to the individual nerve cells can extend beyond the body of the drinking person to the family and community in which she lives.

Not everyone's CNS responds in the same way to alcohol. A number of differences in the nervous system become apparent when comparing different individuals who drink. These differences tend to separate high tolerance from low tolerance, and a predominance of excitatory responses from primary sedative effects. These are considered further in the Central Nervous System and Alcohol Use.

Upon completion of this unit, participants will have:

- reviewed the structure and function of the CNS
- discussed the effects of alcohol on the CNS
- linked specific behaviors to the effects of alcohol on the CNS
- examined the differences between high and low tolerance in various types of drinkers
- explored ways of integrating American Indian cultural values and concepts in the teaching of physiology

Section I

The Central Nervous System

Overview

The central nervous system (CNS), like the body in general, is described by the current science paradigm as a machine. The Medicine Circle incorporates that view and enlarges it by considering the emotional, spiritual, and mental aspects in addition to the physical.

Outcomes

Upon completion of this section, participants will have:

- considered the Medicine Circle as a model for studying the CNS
- read a Sioux story that will be incorporated into the lessons of the CNS
- discussed the importance of keeping classroom lessons relevant to the cultural experiences of the learners

The Central Nervous System

The current paradigm of science describes the universe as functioning like a complex mechanical system. Even the evolution of cellular life is seen as a mechanistic process of mutation and natural selection that eventually resulted in a hierarchical arrangement of simple to complex organisms. At some point during this evolution a spectacular event occurred: unconscious matter became aware of itself. This event is not explained by current science. It is not even seriously attempted, yet the mechanistic view of the physical development is taken for granted. Consciousness is seen as the product of highly organized physical matter -- the Central Nervous System (CNS).

Observations demonstrate that there is a close connection between consciousness and the brain, but they do not prove that consciousness is produced by the brain. Spiritual awareness, feelings of love, an emotional response to beauty, or a sense of connectedness with nature are not explained by the mechanistic paradigm that contends in the words of John Locke that "there is nothing in the intellect that had not first been processed through the senses" (Grof, 1985).

The Medicine Circle represents a more complete view of nature than the mechanistic model, and includes in its description elements beyond perception by the senses. The wealth of profound knowledge about the human psyche and consciousness accumulated within ancient cultures and traditions from all over the world has not been adequately acknowledged or integrated by euro-ethnic science (Grof, 1985).

As the nerves and brain are considered in this unit, emphasis is placed on the integration of a holistic perspective in understanding their functions. This includes the use of the Medicine Circle, American Indian stories, discussions and interactions.

In the following adapted story, a young Brule Sioux hunter learns how to make a flute from a teacher who comes to him during a vision. The vision is the source of new knowledge which contributes to the well-being of the individual as well as the village and the people to come. As we study about the brain and nerves we will refer to this legend to enhance and contextualize learning.

"The Legend of the Flute"

> Once many generations ago during the time of our grandfathers and grandmothers, the people had turtle shells, gourds and drums, but they had no flutes. During this time a young man who had no elk medicine decided to go hunting. He wanted to shoot an elk to bring the meat to his people. He also wanted to possess elk medicine because it would make him a good hunter. The elk, who is wise and swift, also has the power of the love charm. With this medicine, a man can choose the woman he likes to be his wife.
>
> After walking for a full day, he sighted his game. His quiver was full of sharp tipped arrows that flew straight because of the new feathers on them, but the elk managed to stay out of range. The young hunter would retrieve his arrows and return them to his quiver, hoping to put them to better use next time that he shot them.
>
> When night came, he realized he was lost in a forest. There was no moon and the elk was gone. He wrapped himself in his hide robe to keep warm and leaned against a tree to sleep. But he could no't sleep. He heard too many sounds. He heard the cries of night animals and the groaning of trees in the wind. And then he heard a new sound. It was mournful and ghost-like, but also full of yearning and love. He fell asleep to this strange sound and dreamed of a woodpecker. This bird sang with the same sound he heard when he was awake. The woodpecker was telling the young man in his dream to follow him.

When he awoke, he saw the red head of the woodpecker who was flying from tree to tree and looking back as if to say, "Come with me". Then he heard the sound again and saw the bird fly toward it. At last, it lighted on a cedar tree and began to make holes in a branch. Then a gust of wind came and the hunter heard the beautiful sound again. "You can make another branch, Woodpecker. Let me take this branch home," he said.

He returned to his village with the stick. He tried very hard to make the sound with the stick, but could not do it. This made him sad so he purified himself in a sweat lodge and climbed to the top of a quiet hill. There he fasted for four days crying for a vision that would tell him how to make the branch sing. On the night of the fourth day the bird appeared and turned himself into a man. In this vision the man said, "Watch", and the young man watched very carefully.

When he awoke the next morning, he immediately began to follow the directions of the man in the dream. When he was finished he prayed and smoked the branch with burning sage, cedar and sweetgrass. Then he fingered the holes and blew softly into the hole at the end and the beautiful ghost-like sound drifted down to the village. With the help of the wind and the woodpecker, the young man had brought them the first flute.

In the village was the proud daughter of a big chief. Many had come courting her, but she had sent them all away. She was waiting for the right man. When she heard the flute, she knew that she had found him. She said to the young man when she had found him, "I am yours altogether. Let your parents send a gift to my father." The parents agreed to the wishes of their children and soon they were married.

Other young men saw what happened and learned to make their flutes and to play them to bring their lovers to them. That is how the flute was brought to the people, thanks to the cedar, the woodpecker, and the young hunter who shot no elk, but knew how to listen. Adapted from "The Legend of the Flute" told by Henry Crow Dog, 1967.

By knowing the stories, legends and myths of communities in which they work, educators can create culturally relevant lessons for their students. This story from the Sioux tribe has components that are specific to the midwest tribes. Because of the large number of American Indian groups in the U.S. and the diversity within these groups, it is important for educators to choose stories from the particular communities their students represent.

Questions

1. How is the Medicine Circle a more complete model than the machine in considering the CNS?

2. What role can a story play in making learning science more effective?

Training Activities

These training activities assist participants to understand and apply the content of this section. These may easily be adapted for classroom application with students.

1. Ask participants to imagine one of their classmates or teachers is from Mars. They then try to explain how to play basketball by using examples and analogies that the Martian does not understand. (The ball is orange like the fruit; you run quickly as if a bear is chasing you, but the Martian doesn't know what a bear or an orange is). Discuss the feelings this kind of communication creates in the "Martian" and the students. Discuss what lessons can be learned from this activity?

2. Ask participants to consider how the CNS can be reflected in the Medicine Circle.

Section II

The Nerves

Overview

Neurons (nerve cells) carry information from one part of the body to another and from the outside of the body to the brain. Neurons are not physically connected to each other. Information travels between the microscopic spaces between them by the release of neurotransmitters. As one neuron releases neurotransmitters into the synaptic gap (the space between the neurons), the next neuron receives them and knows to send the information to the next cell. This is a delicate and intricate process that can be altered by the presence of alcohol in the nervous system.

Outcomes

Upon completion of this section, participants will have:

- considered the nervous system from the Medicine Circle concept of wholeness and balance
- explored the basic structure of neurons
- studied the principle controlling an action potential
- examined the process of a synapse
- reviewed the function of neurotransmitters
- discussed some of the effects of alcohol on neurons

The Nerves

The nerve cell, or neuron, is the basic structural and functional component of the nervous system. Its shape makes it the ideal unit for information passage around the body. These cells are so important that they are all set in place from early embryonic development and are unable to divide. For this reason, once development has been completed, many neurons cannot be replaced when they die or are destroyed.

Neurons are specialized to receive, conduct, and transmit nervous impulses. Although they can differ widely in size and shape, each neuron consists of three main regions. 1) The dendrites carry information into the cell. 2) The soma, or cell body contains the nucleus and the information that the cell needs to form neurotransmitters (chemicals that pass information from cell to cell) and other proteins. 3) The axon carries information away from the cell body and releases neurotransmitters so that the next cell down the line is activated. At the end of the axon are terminal endings or boutons where neurotransmitters are released into the synaptic gap. (See Handout 1.)

Neurons are not actually in physical contact with one another. The synaptic gap that separates the axon tip of the transmitting (pre-synaptic) neuron from the receiving (post-synaptic) neuron is about 20 nanometers -- 20 billionths of a meter (Bloom and Lazerson, 1988). Interneuronal communication is accomplished by chemicals known as neurotransmitters. These chemicals are released from the axon, cross the synapse, and bind to the surface of the dendrite. (See Handout 2.)

A fluid covering or membrane surrounds each neuron. This membrane has many functions including keeping in needed substances such as glucose and amino acids, keeping toxins from entering the cell, and allowing metabolic wastes to be removed from the cell. Along with these maintenance functions, the neuronal membrane plays a role that is vital to the passage of information along the nerve, and the passage of that information to the next nerve in line. The key to this important role is that the neuron is impermeable to charged molecules, known as ions, and causes a separation of charge from the inside of the membrane to outside of the membrane. The inside of the cell is slightly more negative than the outside of the cell. This is an important factor in information travel since it is a disturbance in the normal membrane charge difference, or potential, that is transferred from cell to cell to be read by the brain as a message from the body or the environment. Activation of this system can come from inside or outside the body.

The signal that is moved down the cell is called an action potential. Its function is to move information down the cell from the dendrites, through the cell body to the axon and on to the boutons. Here the action potential causes the bouton membrane to release capsules (vesicles) of neurotransmitter into the space at the end of the nerve, the synaptic gap. (See Handout 3.)

The action of information transfer from one cell to the next is called a synapse. The electrical activity of the action potential causes vesicles filled with neurotransmitters to be released. The vesicles move to the tip of the bouton and open and release neurotransmitters into the synaptic gap. The neurotransmitters then either activate or inhibit the receptors of the next neurons to behave in the same way.

There are approximately 40 to 50 known neurotransmitters but generally speaking, there are only 2 messages one neuron can pass on to the next -- excitation (one cell commands another to activity) and inhibition (the receiving cell is prevented from firing).

When neurotransmitters defuse across the synaptic gap they find receptor sites on post-synaptic membranes to which they can bind. It is believed that these neurotransmitters have shapes that lock onto the shapes embedded in the post-synaptic membrane, much as pieces of a jigsaw puzzle fit together, or the way that only a particular key can open a lock. Or, like the proud daughter in "The Legend of the Flute", only the right suitor is accepted. (See Handout 4.)

Once neurotransmitters are released into the synaptic gap and bind to their receptor, they are either rapidly broken down by enzymes that are specific for the type of neurotransmitter at a given site, or re-uptaken into the neuron from which they came (just as the young hunter returned his arrows to his quiver). The purpose of this is to insure that the desired effect only occurs for a short amount of time. (See Handout 5.)

Recreational drugs work by inhibiting the breakdown of neurotransmitters or inhibiting its re-uptake. Cocaine, for example, blocks the re-uptake of a specific neurotransmitter, dopamine, and keeps the effect occurring for a longer period of time. Since dopamine is thought to mediate the pleasurable or rewarding effects of drugs, the person feels euphoric or "up".

Effects of alcohol can readily be seen in all aspects of neuronal functioning. They may be particularly revealing in their relation to intoxicated behavior at the synapses. Alcohol damages and destroys cells. The neurons respond to alcohol by adapting to attempt to maintain their functioning and survival. These homeostatic measures allow an organism to become tolerant of alcohol.

Not everyone's system responds in the same way to the presence of alcohol. Differences are obvious when individual responses to drinking are compared. The term "innate tolerance" describes differences in a person's initial sensitivity to alcohol (Harris and Buck, 1990).

Tolerance occurs when the brain adapts to alcohol and functions more or less normally in its presence. In fact, after this adaptation, alcohol becomes a requirement for normal functioning. Often withdrawal from alcohol results in adverse symptoms indicative of physical dependence. Two important consequences of tolerance are as follows: 1) the effect of a given dose of alcohol decreases as tolerance develops and 2) a greater dose of alcohol is required to produce an effect. In other words, tolerance means that more drug is needed to produce a particular effect. Individuals may become tolerant to the desired effects of alcohol as well as to its unpleasant ones. Tolerance may develop after prolonged exposure to alcohol (protracted tolerance) or after a single exposure (acute tolerance).

Calcium causes neurons to release neurotransmitter into the synaptic gap. An example of tolerance occurs when alcohol inhibits the effect of ions on the membrane of a pre-synaptic neuron. As a response, the cell moves its vesicles which store neurotransmitters closer to the pre-synaptic membrane, clumping them together. This lowers the number of calcium ions needed to trigger a release of neurotransmitters into the synapse. Therefore, even though fewer calcium ions get through the neuronal membrane because of the presence of alcohol, more neurotransmitter is available in the synapse during intoxication.

Three major neurotransmitters affected by alcohol are norepinephrine, dopamine, and serotonin. Increased norepinephrine production following chronic alcohol use has been reported. During alcohol withdrawal and after many of the acute symptoms of withdrawal have disappeared, norepinephrine release and activity increase (Tabakoff et al., 1990). This rise in norepinephrine may be linked to sleep disturbances and altered temperature regulation that occur during and subsequent to alcohol withdrawal. Increased norepinephrine activity appears to affect rapid eye movement (REM) sleep, a stage of sleep associated with dreaming. During withdrawal, REM sleep increases causing a disruptive sleep pattern (Tabakoff, et al., 1990).

During alcohol consumption, the production and release of dopamine is increased. Studies indicate that some people have low levels of dopamine (Tabakoff, Hoffman, & Peterson, 1990). It may be they use alcohol to boost their low dopamine levels.

Serotonin acts as an inhibitor of pain pathways and its effect in the brain is believed to help control the mood of a person. It is also considered to be involved in sleep and dreaming (Somjen, 1983). Decreased serotonin levels are associated with anti-social personality disorders, violence, and impulsive behavior (Tabakoff, et al., 1990). Patients who experience major depression and some individuals who commit suicide have been found to have impaired function of the serotonin system. It has been noted that these problems are more prevalent in alcoholic populations.

The level of the major breakdown product (metabolite) of serotonin is a good measure of how much serotonin an individual produces because for every one serotonin molecule used, you get a specific amount of the metabolite. This metabolite has been found to be low in alcoholics. This suggests two possibilities. One is that lowered serotonin activity may be an inherent trait of some alcoholics. The other possibility is that chronic drinking may lower serotonin activity.

Studies suggest that alcohol intoxication may be a means to self-medicate by people who either have inherently low levels of serotonin or who have developed low serotonin levels as an adaptation to chronic heavy alcohol use. In one study while alcoholic subjects were drinking, their serotonin levels were normal, but during withdrawal the levels became abnormally low. Interestingly, drugs that inhibit serotonin uptake by neurons (i.e., drugs which prolong the action of serotonin by allowing it to persist in the synapse), reduce alcohol intake in animals selectively bred to consume large amounts of alcohol. Moreover, research using humans has found a modest reduction in drinking when these drugs are taken.

Neurotransmitter turnover is defined as the amount of neurotransmitter produced, released, then used or recycled in a given time period. High turnover suggests high production and use. As serotonin turnover becomes higher when an individual drinks, signs of high serotonin levels become obvious. Sedation, caused by serotonin, becomes apparent.

As alcohol consumption continues, low tolerance drinkers experience sleepiness. Massive doses drunk quickly, as in teenage chugging contests, can increase the serotonin depression so that the drinker falls into a coma and breathing stops completely. This lethal overdose is known as alcohol poisoning. Interestingly, chronic drinkers as well as high tolerant inexperienced drinkers seem to be able to physiologically adjust their neurochemistry to the effects of large quantities of alcohol.

Adjustment in these drinkers seems to occur at the post-synaptic membrane where individual neurotransmitter receptors may become, or already be, damaged. This means that they are unable to incorporate large amounts of serotonin and increased levels have no apparent effect on these people. It may be this reason that in many cases the heavy drinker seems less drunk or sedated than a non-tolerant drinker who has consumed less alcohol.

The neurotransmitters discussed above have mainly stimulatory effects on the brain. Not all neurotransmitters stimulate, some inhibit neuron activity. These are extremely important in the brain to modulate the effects of the other stimulatory neurotransmitters. These inhibitory neurotransmitters work to dampen responses or inhibit neuronal activity that may be inappropriate.

Gamma aminobutyric acid (GABA) is the major inhibitory neurotransmitter in the brain. It works by binding to a neuron and allowing for an increased amount of chloride ions to enter the cell. Chloride ions carry a negative charge with them. This lowers the membrane potential and makes it harder for an excitatory response to occur with stimulation of the cell. In this manner GABA acts as a brake for excitability.

When GABA levels are low, inhibition of neuron activity decreases. In other words, the neurons are more excitable. The personality effects of this are anxiety, irritability, and agitation. It is believed that drinking alcohol normally increases GABA levels in the brain. The infrequent drinker experiences a rise in GABA from drinking alcohol. Serotonin levels also increase from the alcohol and he gets sleepy and eventually passes out. The tolerant drinker (because of long term drinking or genetic predisposition) has fewer GABA receptors. With less receptors, less of the effects of GABA are seen. In actuality, with the loss of receptors, a tolerant drinker shows very different responses to increased GABA from drinking. When he drinks huge quantities, he experiences a decrease in GABA activity. He tends to become more agitated, excitable, stimulated and obnoxious instead of sedated and sleepy. The GABA system's responses to alcohol probably best fit the observed behaviors of high and low tolerance, as a model of a neurochemical basis of alcoholism (Harris and Buck, 1990).

GABA neurons are some of the smallest and last to develop before and even after birth. They are sensitive to developmental damage by alcohol. This damage could be permanent and irreversible. Some children of alcoholics may have overall insufficient GABA, resulting in higher generic stress and energy levels. Alcohol might be more attractive to them as a tension reducer or stress reliever.

In contrast to GABA, which is the major inhibitory neurotransmitter in the brain, glutamate is the major excitatory neurotransmitter in the brain. Inhibition of the function of this neurotransmitter should have roughly the same overall effect as increasing the function of GABA. One of the glutamate receptors is hypothesized to play a role in learning and memory, neuronal development, seizures, and brain damage resulting from a lack of oxygen in the brain. Activation of this receptor by glutamate results in large uptake of calcium by the neuron, which increases the responsiveness of this cell to stimuli. Research has shown that relatively low levels of alcohol reduce the uptake of calcium that occurs in response to glutamate.

Chronic exposure to alcohol results in a compensatory increase in sensitivity to the excitatory neurotransmitter glutamate. This increased sensitivity in turn may contribute to the neuronal hyperexcitability and seizures that accompany withdrawal, signs of physical dependence.

The balance of incoming and outgoing elements is critically important to the health and vitality of neurons. Nutrients must get into neurons in adequate amounts and proportions to allow them to make repairs, feed themselves, and stay healthy and strong. Waste materials must be eliminated quickly and properly, or the cells become poisoned with their own wastes. Enzymes, hormones, fats and proteins must all be let into the cells at the right time and in the correct amounts or the cells' orderly functioning is damaged. Since cells make up tissues, and tissues are the components of major organs, any significant injury to cells eventually is felt throughout the body and affects how the body functions within itself as well as with others (Milam and Ketcham, 1981).

The presence of alcohol in the body causes damage to neuronal cell membranes so that ions cannot travel across the membranes in a normal fashion. Alcohol appears to cause cell membranes to become less organized. The proteins that normally float in a given orientation in a membrane slip into new positions. This disorganization causes the cell to be unable to send proper signals. Confusion and disorientation of the person is seen (this is the feeling of intoxication). In the neuronal membrane of the chronic alcohol drinker, the neuron tries to make up for the loss of organization by stiffening the membrane so that it is less of a fluid mosaic and more of a wall. If alcohol is removed from the membrane, the wall initially remains stiff. If the ions cannot pass through the wall, the cell begins to pass action potentials down the axon at a rapid rate due to the abnormal build-up of ions within a neuron. (See Handout 6.)

Some tolerant drinkers are able to incorporate fatty acids (cholesterols) into their neuronal membranes so as to resist the disrupting effect of alcohol. This restores the function of the membranes and neurotransmitter ions can continue to pass through. The result of this is central to the concept of tolerance in which heavy drinkers can continue to function but light drinkers begin to slur, sway and stumble. We do not know why or exactly how heavy drinkers can do this. Most likely this is a genetic trait that removes an essential biological control that prevents most drinkers from drinking large quantities. It is not known whether this resistance to fluidization of the membranes occurs gradually, quickly, or whether heavy drinkers' membranes are stiffer to begin with.

The function of neurons is to communicate with all parts of the body and allow for the entire body to be aware of what is going on in and around itself. The dendrites take in information in the form of electrical impulses. They pass these impulses to the cell body where they then go out the axon to the next cell. All of the information that is passed along the nerves is processed together so that changes in any area can generate appropriate responses. The processing center for this information is the brain, the focus of the next section.

Questions

1. What are the various parts and functions of a nerve cell?

2. What is a synapse?

3. How can the process and wisdom of re-uptake be described?

4. In what ways do people differ in their response to alcohol?

5. What are some ways in which alcohol affects the functioning of nerve cells?

Training Activities

These training activities assist participants to understand and apply the content of this section. These may easily be adapted for classroom application with students.

1. Have participants write papers titled "I'm a Nerve Cell and Here's How I Work." This may be done in small groups or as a large group activity. Assign one participant as the writer who writes a "sloppy copy" as the others dictate the paper. Each participant can then edit and rewrite from the copy generated by the entire group.

2. Ask one participant to stand in front of the group. He calls on other participants who may ask him any question about the CNS. If he cannot answer a question, the participant who asked the question takes his place at the front. (Two or three participants may stand at the front and take turns fielding questions.)

3. The shape of a nerve cell is often repeated in nature. Ask for examples: lightening, trees, roots, cracked ice, circulatory system, computer program design, etc.

4. Show participants the overhead illustrating re-uptake. Ask them to illustrate the process with characters from stories that reflect their culture.

5. Have participants play the roles of ions and act out an action potential. They could represent positive or negative charges with different body positions or with cards marked + on one side and - on the other.

Notes - Section II

Section III

The Brain

Overview

The brain, at the top of the spinal cord, contains centers for complex integration of homeostasis, perception, movement, intellect, and emotion. There are many ways of organizing the various parts and functions of the brain for study. Here, for the purpose of examining the effects of alcohol on the brain, it has been segmented into hindbrain, midbrain, and forebrain. In reality, of course, these distinctions do not exist.

Outcomes

Upon completion of this section, participants will have:

- examined the role of the cerebrospinal fluid and the blood-brain barrier in the functioning of the brain
- studied ways the hindbrain, midbrain, and forebrain are affected by alcohol
- considered the differences in reaction to alcohol of high and low tolerance drinkers
- examined the role of the different areas within the cortex and alcohol's effects on them

The Brain

The brain contains about 12 billion neurons. Although we do not know exactly how or where thinking takes place, we do know that a rhythmic interaction among neurons goes on continuously. The possibilities for relaying information are almost infinite; one neuron can be linked to as many as 600,000 other neurons (Pearce, 1977).

When the brain malfunctions due to the disruptive effects of alcohol, information is not correctly received or sent out. Alcohol's effects are not limited nor specific to any particular area of the brain. All areas are affected -- although some more quickly and extensively than others. The areas less critical to life functions are affected first before more essential centers. That is why judgment is altered before breathing. (See Handout 7.)

In order to study the brain, we arbitrarily subdivide it. The brain can be subdivided in many different ways. For the purpose of understanding the effects of alcohol on the brain, the divisions of hindbrain, midbrain and forebrain are useful. All of these areas are protected by the blood-brain barrier. (See Handout 8.)

Glucose, oxygen and ions pass rapidly from the circulating blood into the cerebrospinal fluid of the brain. The tissue that separates the blood from this fluid is known as the blood-brain barrier. It is important to keep blood out of the brain because it often carries antibodies that destroy brain tissue. Cerebrospinal fluid is the substance that feeds the brain tissues. This fluid functions as the blood does in other parts of the body. It brings nutrients into the brain and takes waste products out. (See Handout 9.)

Some substances travel quite easily across the barrier, such as glucose and ions. Other substances such as insulin enter only very slowly. Many substances cannot enter the brain at all. The differential entry rates are due to the presence of the blood-brain barrier. One of the important functions of the barrier is to keep toxins from crossing into the brain. Alcohol is a small molecule that can cross the membrane and enter the brain. The cells of the brain readily absorb the alcohol and become disorganized, causing the effects seen in a person who is drunk.

As noted above, the effects of consuming alcohol are different for different people. Small amounts of alcohol reach the blood-brain barrier of the moderate low-tolerance drinker. Aldehyde dehydrogenase is a major enzyme system of the body that breaks down and removes many aldehydes (e.g. formaldehyde) most of which are toxic to the system. In moderate drinkers, the aldehyde dehydrogenase system will pick up acetaldehyde, a metabolite of alcohol, before it has a chance to contact the blood-brain barrier. Several conditions may prevent this, however. If, for example, the aldehyde dehydrogenase system is overtaxed by poor nutrition, excess yeast in the body, or other aldehydes (Nutra-Sweet ends up as formaldehyde in the body), it may not be able to remove acetaldehyde fast enough. Acetaldehyde passes readily through the blood-brain barrier, even easier than alcohol itself. In addition, acetaldehyde tends to leave the blood-brain barrier open after it passes into the brain. In a sense, it de-activates the barrier so that other foreign chemicals may pass in and out, until the barrier can close again. Some people may have inherited less active aldehyde dehydrogenase enzymes. (See Handout 10.)

When large amounts of alcohol are consumed, more acetaldehyde is produced, creating a greater opportunity for some of this poison to enter the brain. Interestingly, some of the unnatural aldehyde derivatives, condensed by the mixture of acetaldehyde and neurotransmitters, seem to have the ability to antagonize or inactivate the aldehyde dehydrogenase enzyme system, which is the very system necessary to remove acetaldehyde. A spiraling increase in acetaldehyde levels may result. The blood-brain barrier becomes chronically and progressively more ineffective in blocking alcohol and all other chemicals which should not ordinarily get through.

A. Hindbrain

The hindbrain (sometimes referred to as brainstem) is the oldest portion of the human brain. It is the part of the brain that we have in common with all other members of the vertebrate world. It is located at the base of the brain and is directly connected with the spinal cord. This is the area where respiration, heart rate and some reflex action such as gagging and vomiting are controlled. This is the survival area of the brain that automatically controls the functions of the important organs of the body so that the body operates even when the person is a sleep or unconscious.

Alcohol enters the cells of the hindbrain after crossing the blood-brain barrier and can sedate the breathing centers and other areas. One area of the hindbrain that is directly affected by alcohol is the sleep-wake cycle. It controls the level of awareness of the person. When it is active the person is awake and functioning. When it is inactive the person experiences drowsiness and low energy levels. Large amounts of alcohol can sedate this area of the brain which in turn causes the higher centers of the brain to be sedated. Once the higher areas are sedated there is little activation of the thinking portions of the brain. With complete sedation (alcohol poisoning) the individual falls into a coma. Death occurs if the brain does not recover. However, alcoholics rarely die from an overdose of alcohol. Low tolerance light drinkers are much more susceptible to disruptions in the hindbrain.

Alcohol can dissolve in the cell membrane and cause it to expand. This expansion, along with other alcohol induced changes in the layers of the membrane, causes disorder (membrane fluidization) which disrupts the function of the membrane (Tabakoff, Hoffman, Peterson, 1990). The resistance to membrane fluidization seen in tolerant drinkers is thought to play a role in preventing sedation of the hindbrain, so that the heavy drinker does not get sleepy or pass out as easily as a nontolerant drinker.

The hindbrain also controls the vomit reflex after the ingestion of a toxin. By the time this area is activated the brain is often very sedated. If a drinker has already gone into a coma, he is at risk of aspirating vomit. This means that vomit is breathed into the lungs because the drinker is not awake enough to clear it from his mouth. This can cause pneumonia or even death by suffocation.

Both tolerant and light drinkers may vomit from drinking, although the tolerant drinker requires more alcohol to induce this response. There is no clear evidence and little research on how they may differ in this respect. Usually, people wake up just before they vomit, or they throw up before they pass out. However, if they are already in a coma, not just passed out (asleep), they may not wake up when they vomit, before they aspirate.

B. Midbrain

The midbrain is smaller and less differentiated than the hindbrain or forebrain. It works mainly as a relay center between the spinal cord and hindbrain and the forebrain. One area of the midbrain is involved in the feeling of strong emotion. It also involves the relay of visual and auditory information. This area is vital in insuring that information from the body and the environment reaches the forebrain, or thinking areas of the brain. Alcohol may sedate the midbrain so that the signals from the outside of the brain are not able to reach the forebrain or are slow in getting there. This means that the thinking portion of the brain is receiving little or no input. Of course, when it has no input it gives off no responses (Carpenter, 1976).

Certain circuits in the brain are thought to have reward or pleasure responses that are activated by alcohol, more so in some drinkers than others. Tolerant drinkers who attain more overall stimulation in the brain, as opposed to sedation, seem to achieve a more powerful, intense, and long lasting intoxication. Typically, all drinkers experience exaggerated emotions when drinking. This becomes greatly pronounced in tolerant drinkers whose emotions become polarized, rigid and extreme as the midbrain functions become predominant with increasing disruption of higher brain, intellectual functioning.

The hypothalamus is a particularly important control center. It resists the sedation of alcohol at all costs because it is necessary to survival. We have a rage center located in the hypothalamus. Again, consistent with the greater stimulation by alcohol of tolerant drinkers, this rage center may be overstimulated with extensive drinking. This may result in tiny localized seizure activity near the rage center which is thought to trigger uncontrollable anger and violent behavior, or at least lower the violence threshold. Up to 80% of all violent crimes, domestic violence, child abuse, rape, assaults, etc. are alcohol-related.

Memory centers are also located in the midbrain and the forebrain. It is interesting that violent rage reactions are often associated with blackouts (loss of memory of a period of time spent drinking). Significant reactions to alcohol such as these are always indicative of serious drinking problems, brain dysfunction and alcoholism.

C. Forebrain

Much of the forebrain is involved in intellect and coordinated movements and sensations. It is this region that is responsible for the "personality" and attitudes of a person. Incoming information from the midbrain synapses on the nerves of the forebrain. Different patterns of stimulation causes the forebrain to react in different ways. Some incoming information, for example, information about a pin in your finger causes the forebrain to send signals to the finger muscles to move away.

Heavy drinkers tend to disable their higher brain centers more or less chronically. Their thinking processes tend to be shunted more and more to midbrain emotional centers. Often they begin to mistake their fantasies for reality, and replace normal cognition with rigid, extreme, black and white thinking patterns, often stereotypes. Frequently their self images are distorted. There are predictable long-term outcomes of higher brain toxicity. Moods also tend to become polarized and more extreme without the cognitive mediation of the outer forebrain.

Synaptic transmission is disrupted during drinking and the understanding of incoming messages is slowed and distorted. Outgoing responses are also interfered with, so that the total result is one of diminished functioning on all levels. The greater the quantity of alcohol ingested, the greater the chemical disruption. Here again, the tolerant drinker's resistance to membrane fluidization and stimulation by alcohol may allow for some adjustment and less sedation. However, this does not mean that she is less intoxicated, but rather intoxicated differently from the light social drinker. This can be extremely dangerous. The light, nontolerant drinker loses his balance and coordination, becomes sleepy, and probably is not inclined to take unnecessary risks. The tolerant drinker, on the other hand, will be hyperactive and coordinated enough to try something foolish. She will not possess the judgment or intellectual controls to offset her fantasies about the glamorous nature of a potentially dangerous activity.

Think about the effects of an impaired forebrain functioning in a tolerant stimulated auto driver. Not only will she believe (feel) that she can make it home, she will tend to speed and pass four other vehicles on a hill, with her lights off. The non-tolerant drinker knows that his brain is not working right and would be less likely to even try to drive.

D. Cerebral Cortex

The cerebral cortex is the outer layer of the brain covering the left and right brain hemispheres. Of the approximately 12 billion neurons in the brain, 9 billion are in the cerebral cortex. Subdivisions of the cerebral cortex are the motor cortex, somatosensory cortex, and the association cortex (Thompson, 1975). (See Handout 11.)

The motor cortex is the area of the brain that controls the movements of the body. This area is laid out in a map that corresponds to the placement of the body. If you artificially stimulate an area of the motor cortex you cause the related area of the body to move. Such a topographical map of the body in the brain is known as a homunculus which means "little body". This homunculus controls the movements of the body by sending information down specialized nerves that control body movement called motor neurons to the spinal cord and then out to the body. A disruption in any part of the pathway can lead to a disruption in the ability to move an area of the body properly. If a large area of the pathway is damaged, paralysis occurs. This is often seen in patients who have had strokes that damaged motor paths. (See Handout 12.)

Alcohol can lead to disruption of the cells in the motor cortex that initiate the movement or in the pathway that the information must travel down. Disruption of the cells of the motor cortex causes inappropriate movements or lack of movement. An example of this is a person's inability to control normal bodily functions such as holding urine in the bladder. Disruption of normal motor pathways that work to control the opening to the bladder causes the bladder sphincter to open spontaneously and urine flows out.

Dopamine synapses are important to voluntary movement motor neurons. During initial stages of intoxication, movements become exaggerated and agitated. Later as post-synaptic receptors become disorganized, movements become uncoordinated and lethargic, gait becomes unsteady because the peripheral nervous system does not receive activating impulses from the brain and spinal cord. Involuntary motor neurons are also affected. Eyes are wide open during initial intoxication, then become difficult to keep open or focused as the sedation sets in.

The area of the brain that receives sensory information from the outside world is the somatosensory cortex. It has a homunculus for the sensation of touch. Its function is to take all incoming information from the senses and integrate it in a manner that the individual can understand. The information coded here allows the person to make decisions regarding behavior.

Alcohol sedates the cells of the somatosensory cortex, causing all of the information coming in to be processed more slowly. Signals to other areas of the brain also move more slowly, as do all outgoing motor signals to the body. This is the other half of the drunk-driving danger. Disruption to the somatosensory cortex functioning prevents accurate assessment of incoming signals and impulses. Again for the heavy drinker, his midbrain tells him that he wants to pass that slowpoke ahead of him. His fantasy tells him that he is Mario Andretti and will surely make it. However, his somatosensory cortex cannot tell him accurately how much clear road he has ahead, how fast he is going in relation to the other cars, nor whether he sees the beginnings of oncoming headlights over the crest of the hill. The information processing needed for these operations is complex and subtle, but his brain is chemically incapacitated. The alcoholic feels like his sensory system is just fine and that he will have no problem negotiating this intricate psychomotor project. Usually, the social drinker will have a better idea of when not to try.

The association cortex takes the incoming information and puts it in order so that the individual knows what she is seeing or hearing, etc. It is the "thinking portion" of the brain. Association nerves connect the information that comes in via the somatosensory cortex with information going out the motor cortex. Alcohol destroys the individual's ability to think. Judgment and reason are damaged and an inability to do anything except follow others is often seen. Damage here also causes dementia because the brain can no longer correctly assess the incoming information and it can incorrectly tell the person what is in the environment.

The association cortex is the seat of reason, judgment, fine discrimination. Without it we make no sense of the world we perceive and cannot choose appropriate responses or behaviors. It is made up of complex columns and sub-areas. With alcohol, its functions are the first to be impaired. In order for messages to get up to the association cortex, they must take a long journey up the spinal cord, through the hindbrain and midbrain. When a person is intoxicated, messages do not get through accurately and intact in the first place. Then they cannot be interpreted and understood well in the association cortex. This, in part, explains inappropriate behavior associated with drinking alcohol. Alcohol is poisonous to every cell in the body; therefore, every aspect of a human being is poisoned by drinking. The greater the amounts, the greater the disruption, even though it may not always appear so.

The brain does not recover quickly from alcohol. Several hours are necessary after the drinking has ceased for the nervous system to recover normal functioning. First, a hyperactive rebound occurs that has physiological implications lasting about three times as long as the amount of time spent under the influence. The system is disrupted, dysfunctional and disorganized, even though there is no actual alcohol present in the body. A drinker who consumes significant amounts of alcohol daily never gives his body time to get through the rebounds. Eventually, the neurons, neurotransmitters, receptors, etc. become irreparably damaged. The brain cannot grow new neurons. It will slowly try to compensate and adapt to find new pathways in order to retain functions. However, if drinking continues, no compensation is possible and deterioration continues. The nervous system declines in a progressively toxic dying process, from the highest intellectual brain areas down through the entire being. The personality and thinking processes become less differentiated, the emotions become more extreme and stereotypic, behavior becomes more volatile and instinctual.

While the brain is composed of different areas that perform under different conditions the key to how we function is in the incredible integration of all the parts of our systems. There are areas that interpret sounds, others that interpret smells, and still others that control muscular movement and send signals out of the brain in response to incoming information, yet the end result is that we can do all of these things at one time. These areas all work together and when one area is damaged, all areas are affected.

Questions

1. Compare and contrast cerebrospinal fluid and blood.

2. What are the primary functions of the hindbrain, midbrain, and forebrain?

3. What is the physiological explanation of some of the typical behavior of alcoholics i.e., moodiness, inability to distinguish between fantasy and reality, raging, etc.

4. Why does an alcoholic or heavy drinker sometimes seem less affected by alcohol than a moderate drinker?

Training Activities

These training activities assist participants to understand and apply the content of this section. These may easily be adapted for classroom application with students.

1. Illustrate how divisions and categorizations are arbitrary by discussing ways of grouping members in a community, acceptable and unacceptable behaviors, parts of the body, functions of the brain, etc.

2. Provide outlines of the brain. Help participants identify the general hindbrain, midbrain and forebrain areas. Color each area a different color and discuss different functions.

3. Create a chart with two columns showing the functions of the brain under healthy conditions and under the influence of alcohol.

4. Discuss the mental, spiritual, physical, and emotional impact of experiencing alcoholism from the point of view of the alcoholic, from the point of view of the alcoholic's child.

5. Compare the blood-brain barrier to a goalie who is trying to keep a soccer ball out of the goal. How are their jobs the same?

6. Ask a recovering alcoholic to come to the classroom and discuss her physiological reactions to drinking. Ask her to describe changes that occurred in her body when she stopped drinking. Ask her to relate her experience to all the areas of the Medicine Circle.

Notes - Section III

Section IV

Alcohol-Induced Central Nervous System Disorders

Overview

One source of damage to the CNS can be the cause of many different illnesses. Although alcohol can harm every cell in the body, the CNS is vulnerable because of its complexity and intricacy. This section looks at a few possible alcohol-induced disorders.

Outcomes

Upon completion of this section, participants will have:

- examined five common CNS disorders associated with alcohol abuse
- considered the importance of a holistic approach in the treatment of alcoholism among American Indian populations

Alcohol-Induced Central Nervous System Disorders

As we have read, alcohol can damage the brain in many ways. The brain is susceptible to the toxic effects of alcohol itself and can also be affected by alcohol-related damage to other organs, such as the liver. Further, the nutritional deficiencies found in chronic alcoholics often play a role in CNS damage.

Alcohol acts on the CNS as a depressant. This depressant action disinhibits many higher cortical functions. Because of alcohol's depressant effects, parts of the CNS circuitry are released from their normal inhibitory roles. As a result, certain behaviors ordinarily restrained now occur. Acute intoxication induces mild delirium. Thinking, orientation, recent memory, and higher mental functioning are compromised. Electroencephalograms (EEG) of intoxicated individuals show a diffuse slowing of normal brain waves. Some vulnerable individuals have a dramatic change of personality when they drink even small amounts and may become confused, disoriented, experience visual hallucinations, and be very aggressive, anxious, and impulsive. Described below are a few of the CNS disorders associated with heavy drinking.

Polyneuropathy is a disorder resulting from nutritional deficiencies of the B complex vitamins which weaken and eventually damage the peripheral nerves outside the brain and spinal cord. The first symptoms of polyneuropathy are numbness and tingling sensations in the extremities, usually the toes or fingers. As the condition worsens, the hands and arms, and feet and legs are affected. This disorder is reversible if treated early. In other words, the nerves will heal themselves if the alcoholic abstains from alcohol and eats a proper diet containing a balance of vitamins (particularly the B vitamins) and minerals. However, if the condition is not treated, the damage can become permanent and irreversible. Muscle tone is lost and muscles atrophy in these individuals. In late stage alcoholics with irreversible polyneuropathy, walking, when possible, is usually difficult and clumsy.

Wernicke's Syndrome is produced by a severe deficiency in Vitamin B1 or thiamine. A rapid onset of headaches, double vision, abnormal eye movements, the tingling sensations associated with polyneuropathy, muscular incoordination, stupor, and brain hemorrhage are characteristic symptoms of Wernicke's encephalopathy. Moreover, a person with this syndrome is likely to be confused, delirious, agitated, and may experience hallucinations seen in delirium tremens. This disorder is easily reversible when treated quickly with thiamine. It is important to note that Wernicke's syndrome is caused by thiamine deficiency and not alcohol toxicity per se. This conclusion is supported by the fact that the syndrome is quickly (within hours or days) and usually completely reversible when treated with thiamine and the syndrome exists in nonalcoholic patients who have a thiamine deficiency.

Korsakoff's Psychosis results from damage to areas of the brain associated with memory function and is often associated with damage to peripheral nerve tissue as well. This disease is caused, in part, by vitamin B1 deficiencies. Severe loss of short-term memory, the consequent fabrication of stories to fill in the gaps termed "confabulation," and hallucinations are hallmark signs of this disease. The affected individual usually remembers distant events but is confused regarding present or recent happenings such as where she is, why she is there, what she just ate or who may be sitting next to her. The memory impairment is greatly out of proportion to other cognitive dysfunctions. A person with Korsakoff's psychosis cannot process and store new information. Prognostically, Korsakoff's syndrome is unlikely to be reversed. Individuals with this debilitating disease will probably end up in a nursing home or require custodial care.

Sleep Disturbance in Alcoholics Although some say they need to drink in order to sleep, it has been found that alcohol interferes with normal sleep. There are four stages of sleep. Each has characteristic brain-wave patters and occur in a predictable sequence in non-drugged, healthy individuals. Alcohol depresses REM (dreaming) sleep and results in more awakening during a night. This fragmentation of sleep and lack of REM sleep in chronic alcoholics is a serious problem since there is little or no recovery value in this type of sleep. This poor sleep makes people want to sleep longer in the morning and during the day which adds to the stresses of life. When alcohol is withdrawn from the alcoholic, there is a rebound of dreaming. Often there are nightmares because dreaming is so intensive. Increased dreaming can last more than a week before subsiding.

Liver-Brain Effects While some of the CNS malfunctions in an alcoholic result from direct adverse effects of alcohol on the brain, others reflect the presence of a damaged liver. The CNS can be adversely affected by liver disease. Located beneath the diaphragm in the abdominal cavity, the liver acts as a detoxification center by removing toxic substances. It is well documented that alcohol abuse can produce a range of liver injuries including fatty liver, alcoholic hepatitis, and alcoholic cirrhosis. When the liver is diseased, its ability to metabolize, digest, and detoxify is compromised. Toxins, such as ammonia, remaining in a person with a diseased liver can disrupt normal brain functioning. This conclusion is supported by research comparing cirrhotic alcoholics and nonalcoholics, groups of alcoholics with differing degrees of liver damage, alcoholics before and after liver transplantation, and the correlation between biochemical measures of liver function and damage to neurocognitive test performance. These results imply that effective treatment of alcoholic liver disease should improve the CNS functioning of alcoholics.

It is estimated that in the United States there are approximately 10-13 million people in various stages of alcoholism. No segment of society is immune from alcoholism (Mendelson & Mello, 1985). Unfortunately, the epidemiological findings show that American Indians are at higher risk of alcoholism than other groups. In fact, American Indians have the highest incidence of alcohol problems among all U.S. groups.

Earlier in this unit, the importance of cultural relevance was discussed regarding the prospect of successful education. The same consideration is necessary for successful treatment of alcohol abuse. Here again, the Medicine Circle plays an important role. Not just the physical body is devastated by alcohol. A person's mental, emotional, and spiritual well-being are also damaged. Because of the typical American Indian perspective of wholeness all these aspects must be involved in culturally relevant treatment. There is a movement among American Indians to take charge of the treatment and healing of their own communities and to incorporate religious ceremonies and traditional healing practices like the vision quest of the young hunter in the "Legend of the Flute".

Questions

1. What causes disinhibition in a person who is drinking?

2. What are the names and symptoms of several CNS disorders that are caused by alcohol?

3. How do the disorders described affect all the areas represented in the Medicine Circle?

4. Why is a holistic treatment program advised for American Indians who are recovering alcoholics?

Training Activities

These training activities assist participants to understand and apply the content of this section. These may easily be adapted for classroom application with students.

1. In small groups, have one participant be a "patient" describing the symptoms of her alcohol-induced CNS disorder. Have the rest of the group "diagnose" the disorder, state what happened in the body to cause the symptoms, and list any other possible symptoms not mentioned by the patient.

2. Ask small groups of participants to plan a treatment program for alcoholics that is modeled on the Medicine Circle. Ask them to illustrate their plan and present it to the group.

BIBLIOGRAPHIC REFERENCES
CENTRAL NERVOUS SYSTEM AND ALCOHOL USE

Arria, A., Tarter, R. and Van Thiel, D. "Liver-Brain Relation in Alcoholics" in Alcohol, Health and Research World. 14(2), 1990.

Berman, Marlene Oscar. "Severe Brain Dysfunction: Alcohol Korsakoff's Syndrome" in Alcohol, Health and Research World 14(2), 1990.

Bloom, Floyd E. and Lazerson, Arlyne. Brain, Mind, and Behavior. Second edition. New York: W.H. Freeman and Company, 1988.

Caduto, Michael J. and Bruchac, Joseph. Keepers of the Earth: Native American Stories and Environmental Activities for Children. Golden, Colorado: Fulcrum, Inc., 1989.

Campbell, Neil A. Biology. Menlo Park, CA: Benjamin/Cummings Publishing Co. Inc., 1987.

Carlson, Neil R. Physiology of Behavior. Third edition. Massachusetts: Allyn and Bacon, Inc., 1986.

Carpenter, Malcolm B. Human Neuroanatomy. Baltimore: Williams and Wilkins Company, 1976.

Charness, Michael. "Alcohol and the Brain" in Alcohol, Health and Research World, 14(2), 1990.

Crow Dog, Henry. "The Legend of the Flute" in American Indian Myths and Legends. Selected and edited by Richard Erdoes and Alfonso Ortiz. New York: Pantheon Books, 1984.

Fishman, Ross. The Encyclopedia of Psychoactive Drugs: Alcohol and Alcoholism. Solomon H. Snyder editor. Chelsea House Publishers, 1987.

Gray, Henry. Anatomy of the Human Body, ed. Charles Mayo Goss. Philadelphia: Lea and Febiger, reprinted May, 1969.

Grof, Stanislav. Beyond the Brain: Birth, Death and Transcendence in Psychotherapy. Albany: State University of New York Press, 1985.

Guyton, A.C. Human Physiology and Mechanisms of Disease. Fourth edition. Philadelphia: W.B. Saunders Company, 1987.

Harris, A. and Buck, K. "The Process of Alcohol Tolerance and Dependence" in Alcohol, Health and Research World, 14(2), 1990.

Kinney, Jean and Leaton, Gwen. Loosening the Grip: A Handbook of Alcohol Information. St. Louis: Times Mirror/Mosby College Publishing, 1987.

Kuffler, S.W., Nicholls, J.G., Martin, A.R. "Ionic Basis of Resting and Action Potentials" from From Neuron to Neuron. Second edition. Sunderland, MA: Sinauer Associates Inc. Publishers, 1984.

BIBLIOGRAPHIC REFERENCES
THE CENTRAL NERVOUS SYSTEM AND ALCOHOL USE

Mello, N.H. and Mendelson, J.H. Alcohol Use and Abuse in America. Boston: Little Brown Publishers, 1985.

Milam, James R. and Ketcham, Katherine. "Tolerance" from Under The Influence: A Guide to the Myths and Realities of Alcoholism. Seattle: Madrona Publishers, Inc., 1981.

Milkman, Harvey B. and Sunderwirth, Stanley G. "Biochemistry: The Gateway to Excess" from Craving for Ecstasy: The Consciousness and Chemistry of Escape. D.C. Heath and Company, 1987.

National Institute on Alcohol Abuse and Alcoholism. "Alcohol and Cognition" in Alcohol Alert. Rockville, MD: U.S. Department of Health and Human Services, Public Health Service, Alcohol, Drug Abuse, and Mental Health Administration, No. 4, May 1989.

O'Connor, S., Hesselbrock, V. and Bauer, L. "The Nervous System and the Predisposition to Alcohol" in Alcohol, Health and Research World, 14(2), 1990.

Pearce, Joseph C.Magical Child: Rediscovering Nature's Plan For Our Children. Bantam Books, 1977.

Petrakis, Peter L. "Neurochemical and Neurophysi-ological Variations" from Alcoholism: An Inherited Disease. Written for National Institute on Alcohol Abuse & Alcoholism. DHHS Publication No. (ADM) 85 - 1426, 1985.

Rose, R.M and Barrett, J.E. eds. "Overview of the Concept of Tolerance" from Alcoholism: Origins and Outcomes. New York: Raven Press, 1988.

Shields, Lora Mangum. An Overview of Human Biology: Self-Paced Alternatives, Narrative for Test Banks Reverse Multiple Choice Questions. Dubuque: Kendall/Hunt Publishing Company, 1989.

Somjen, G. Neurophiology - The Essentials; the Cycle of Sleeping and Waking. New York: Williams and Wilkins, 1983.

Spence, Alexander P. Basic Human Anatomy. Second edition. Menlo Park, CA: Benjamin/Cummings Publishing Company Inc., 1982.

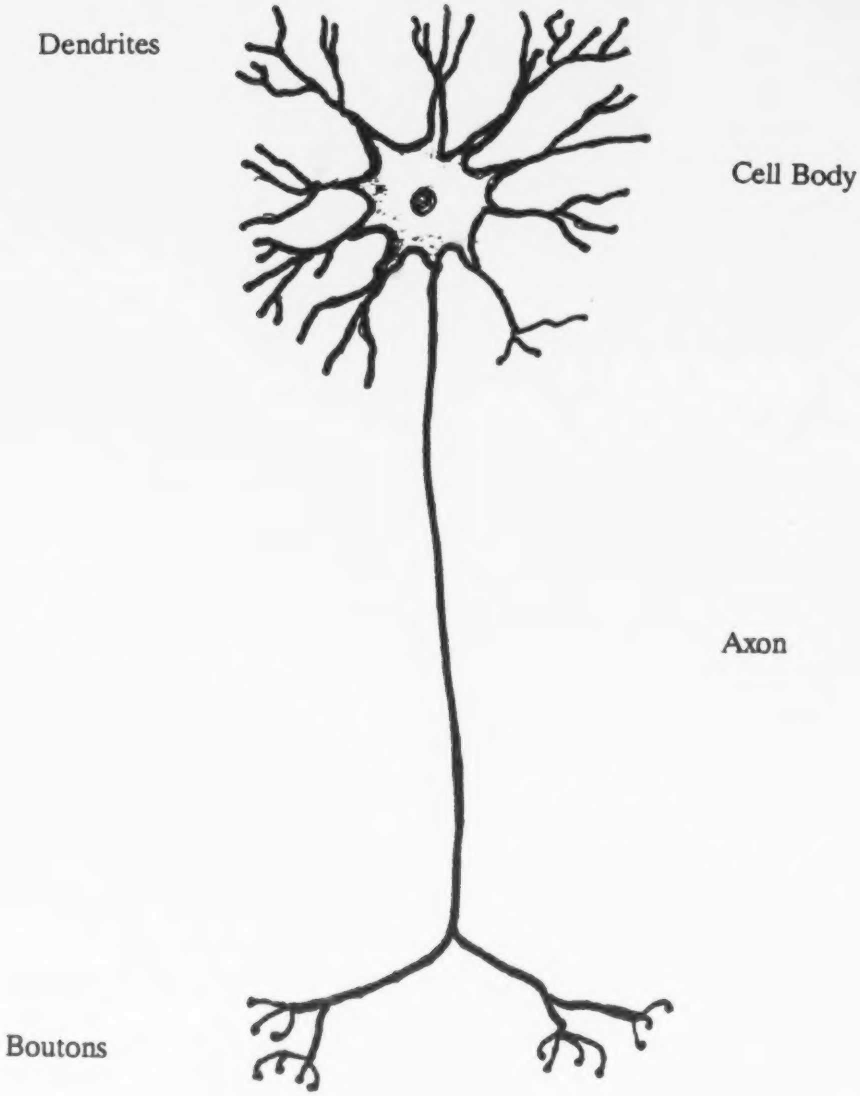
Tabakoff, B., Hoffman, P. and Peterson, R. "Advances in Neurochemistry: A Leading Edge of Alcohol Research" in Alcohol, Health and Research World 14(2), 1990.

Thompson, Richard F. Introduction to Physiological Psychology. New York: Harper and Row, 1975.

Unit Handouts

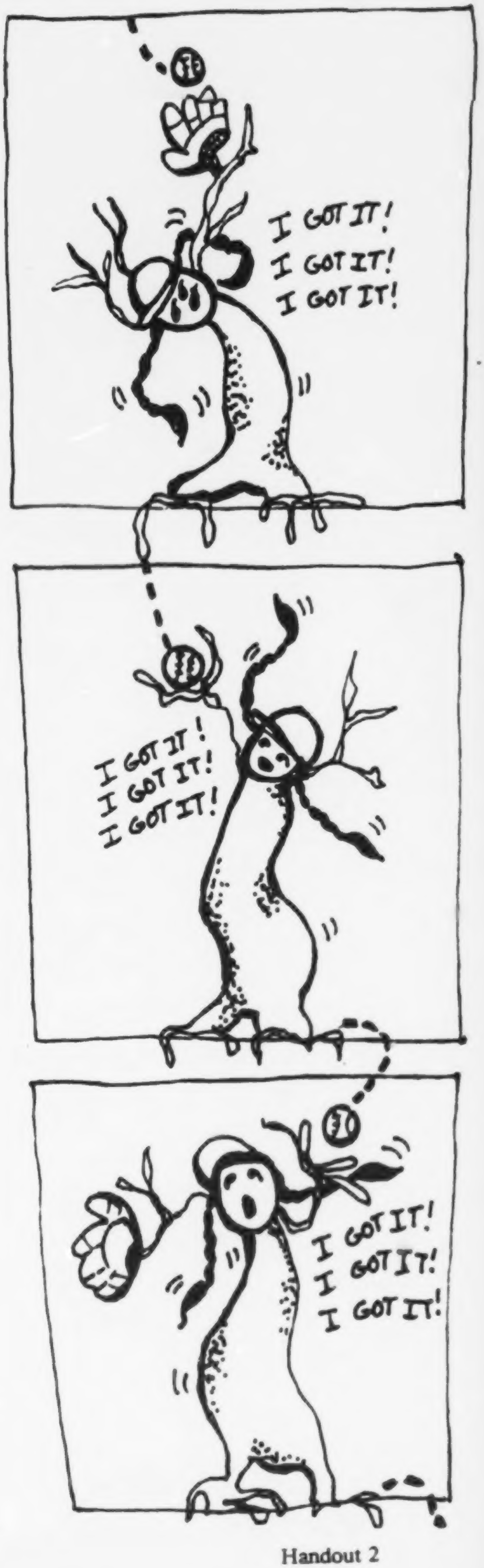
1. One of Cynthia's Neurons
2. Cynthia's Neuronal Communication
3. Action Potential
4. Synaptic Transmission
5. Re-uptake
6. Cell Membrane
7. Out of Balance
8. Cross Section of Cynthia's Brain
9. The Blood-Brain Barrier
10. Acetaldehyde Tends to Leave the Blood-Brain Barrier Open
11. Cynthia's Cerebral Cortex
12. Homunculus

One of Cynthia's Neurons


Dendrites
Cell Body
Axon
Boutons

Handout 1

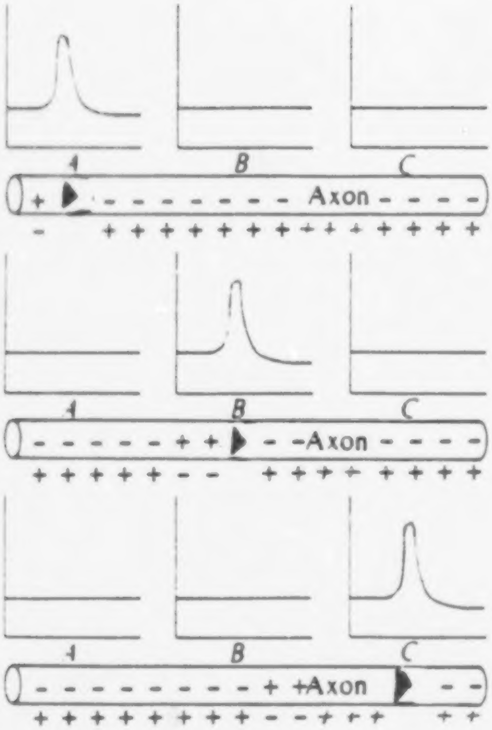
Cynthia's Neuronal Communication


I GOT IT!
I GOT IT!
I GOT IT!
I GOT IT!
I GOT IT!
I GOT IT!
I GOT IT!
I GOT IT!
I GOT IT!

Information travels from one neuron to another through neurotransmitters. These chemicals are released from the boutons at the end of the axon into the synapse, the space between the bouton and the dendrite or cell body of the next neuron.

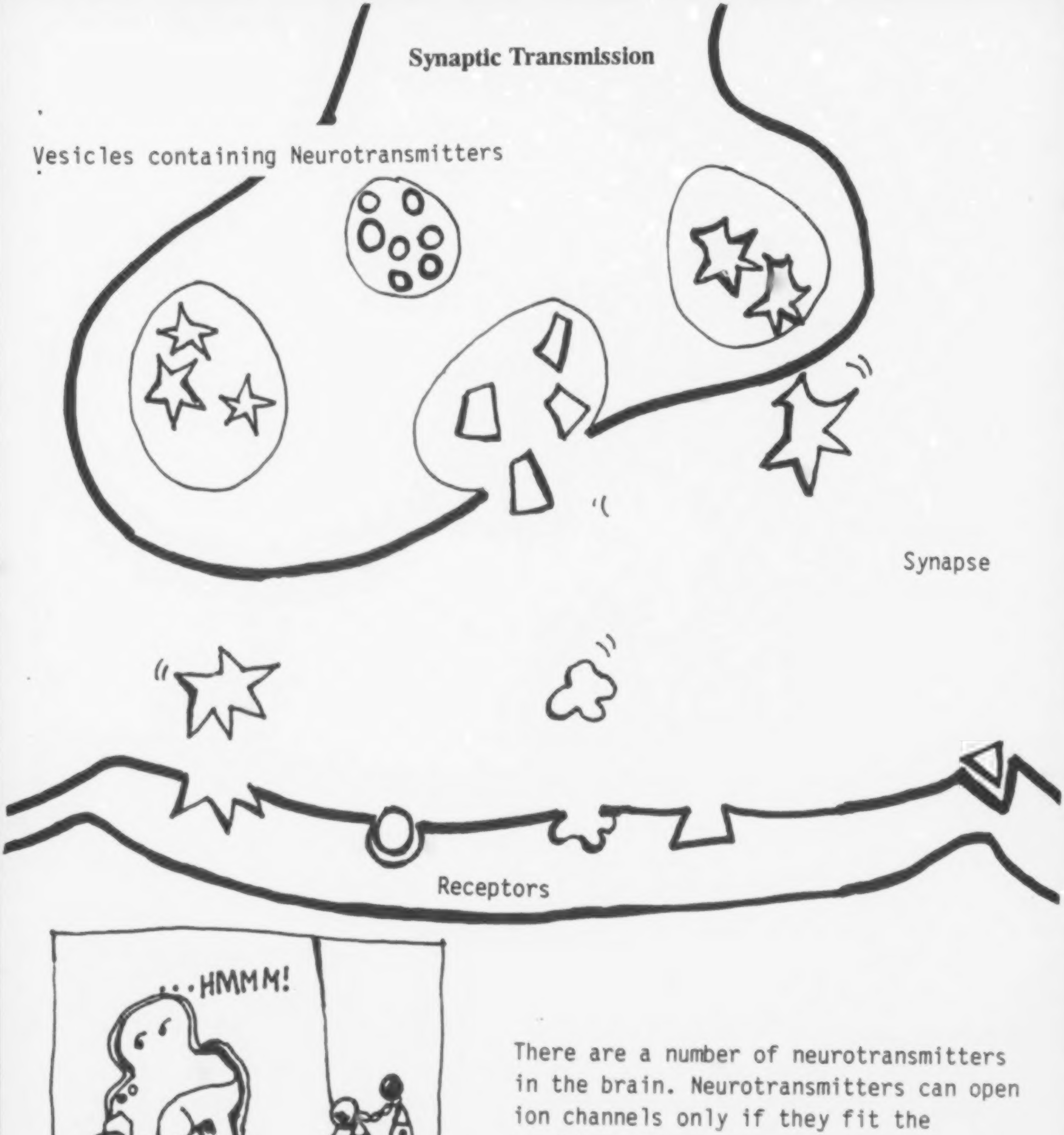
Handout 2

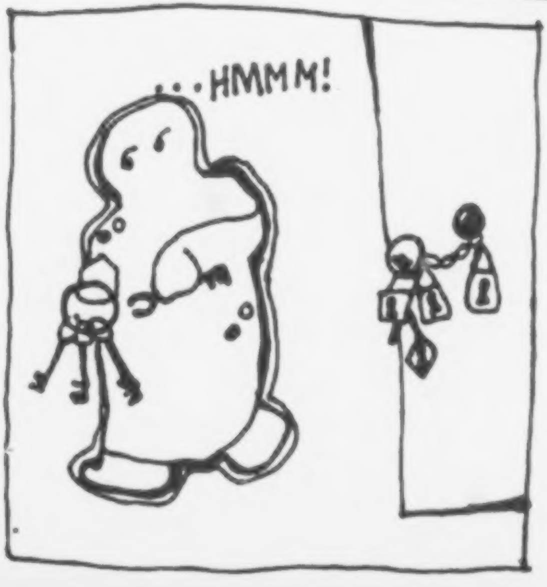
ACTION POTENTIAL


A
B
C
Axon
A
B
C
Axon
A
B
C
Axon

An action potential is a brief change in the electrical potential of a neuron. The change starts at the dendrite end of the neuron and moves through the cell to the boutons at the end of the axon.

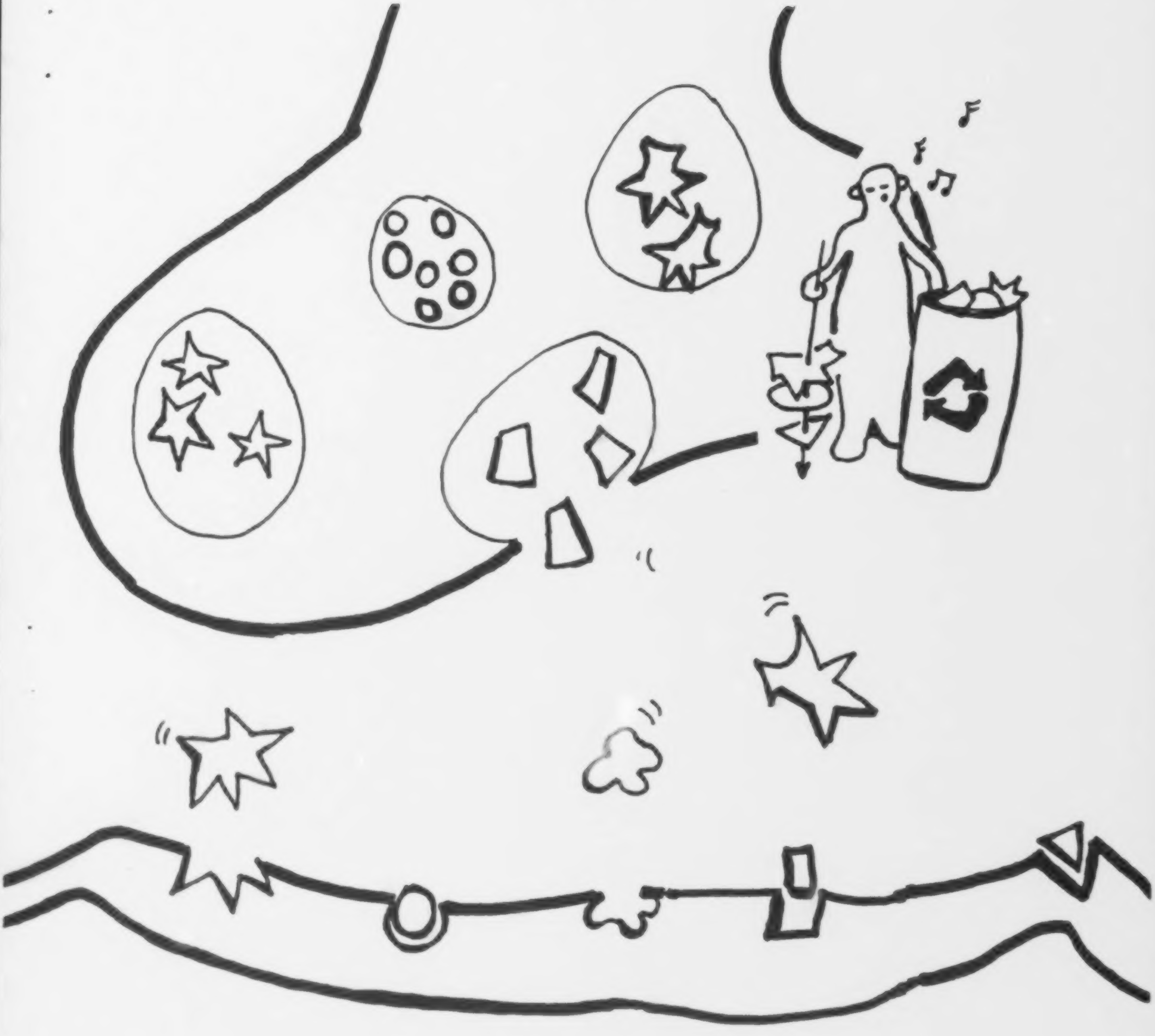
Synaptic Transmission


Vesicles containing Neurotransmitters
Synapse
Receptors



There are a number of neurotransmitters in the brain. Neurotransmitters can open ion channels only if they fit the receptor, like a key in a lock.

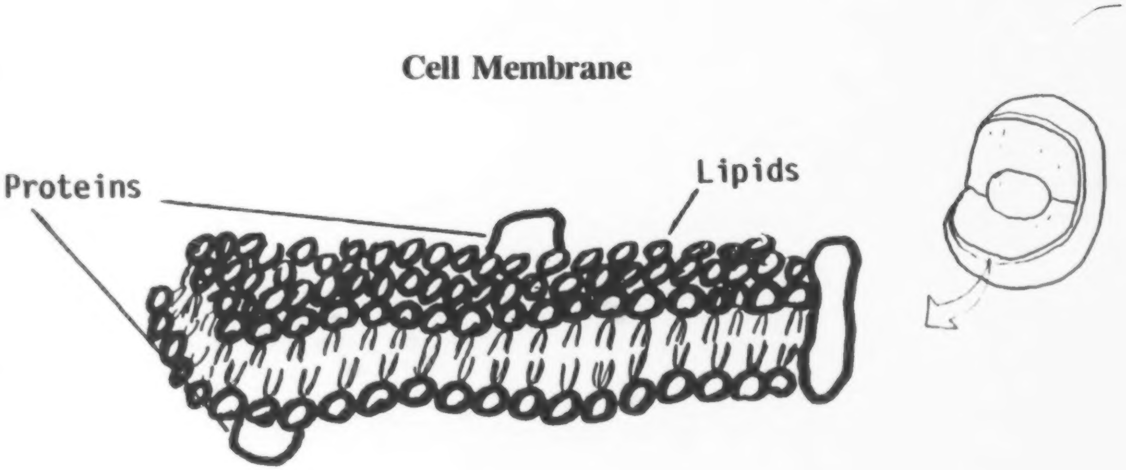
Reuptake



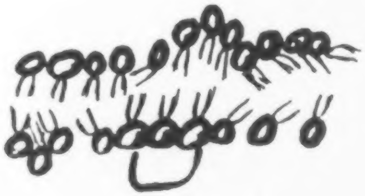
The effects of neurotransmitters are terminated by re-uptake. This process is simply the removal of transmitter substances from the synapse. The cell membrane surrounding the bouton contains a pump-like mechanism that returns the transmitter from the synapse directly into the presynaptic bouton giving the receiving cell only a brief exposure to the transmitter.

Handout 5

Cell Membrane

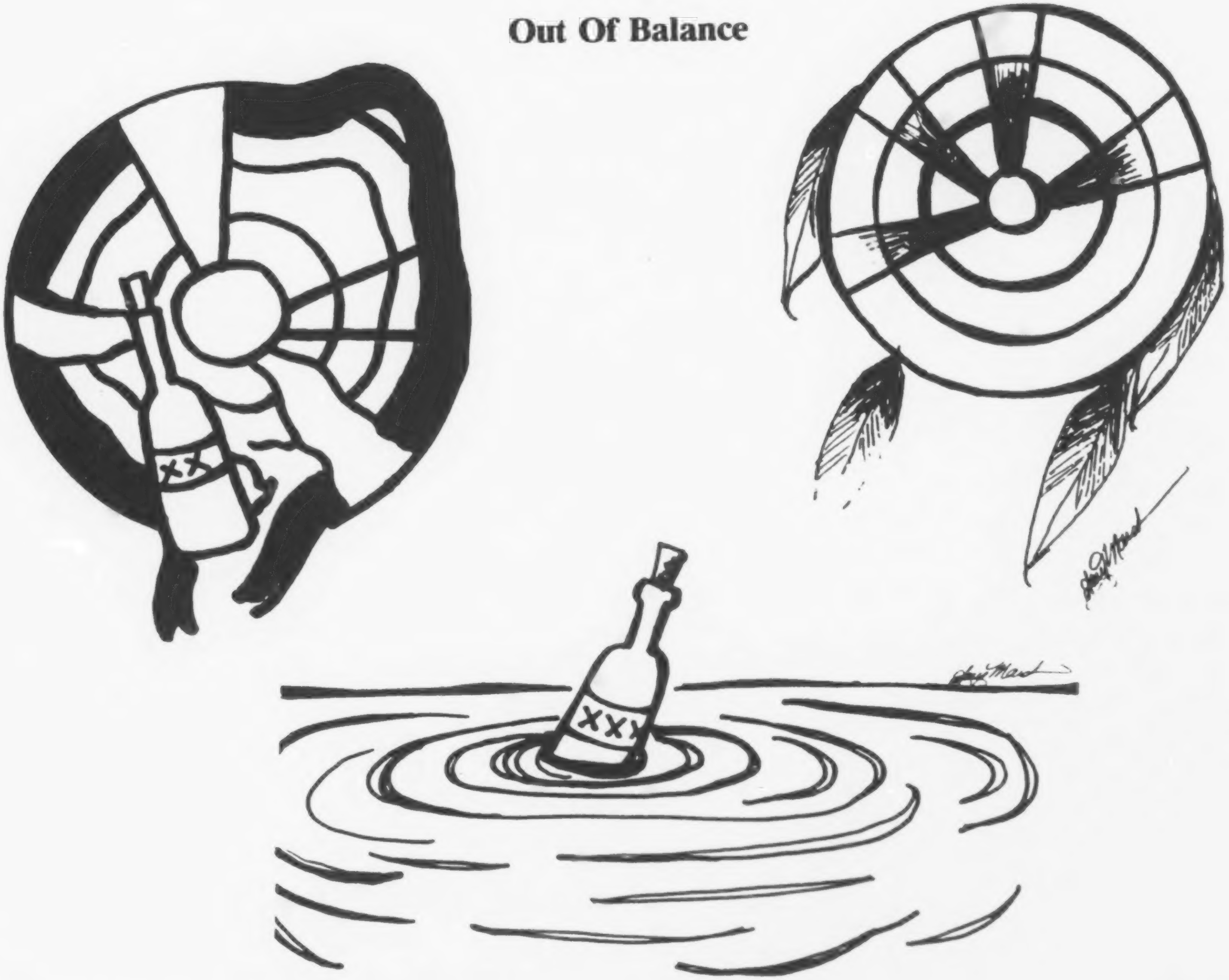


Each cell is surrounded by a cell membrane which is selectively permeable. The membrane is composed of proteins floating in a fluid bilayer (two layers back-to-back) of lipid. Membranes form the outermost layer of most animal cells, including neurons. Materials that enter or leave the cell must pass through this membrane.

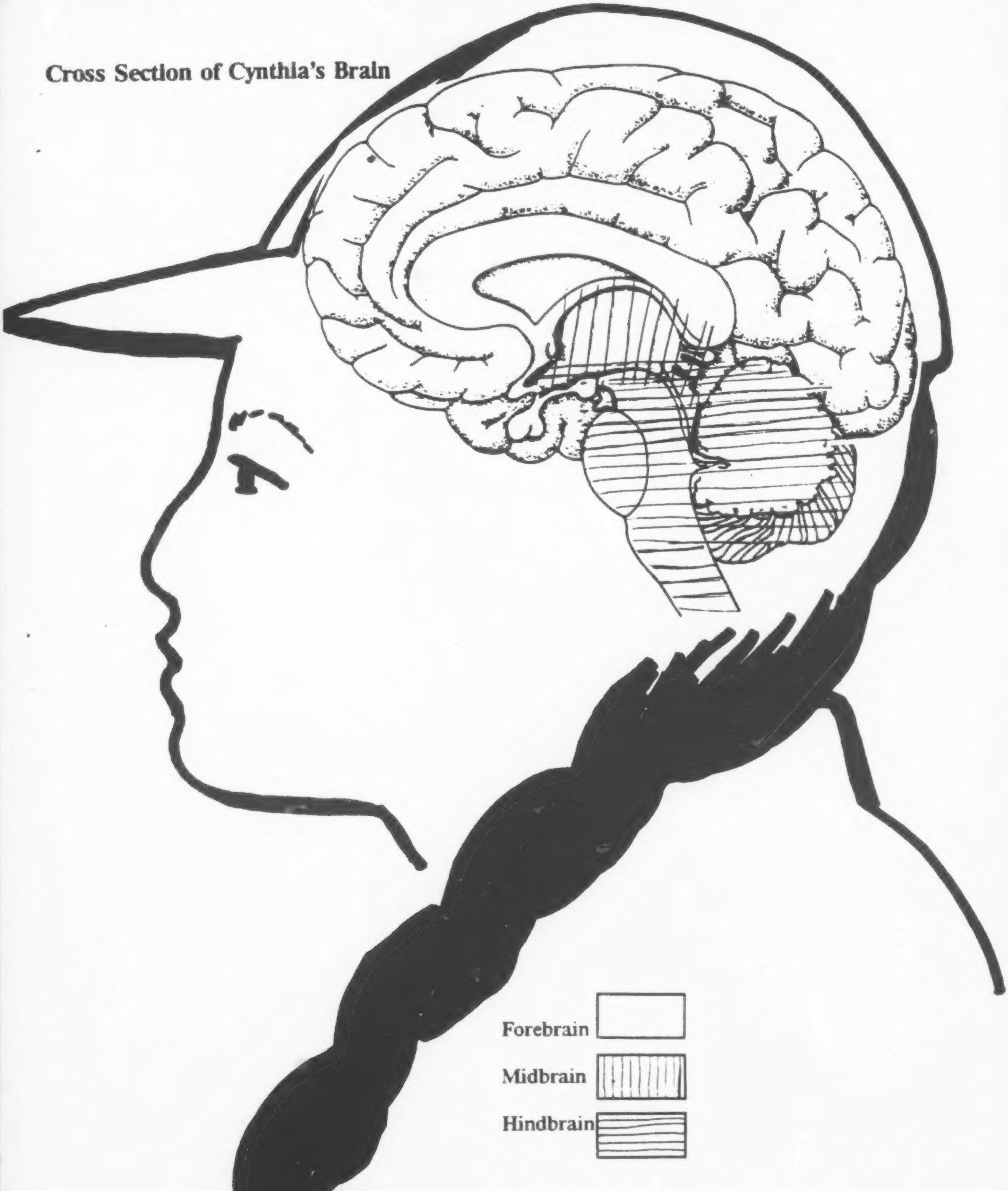


Alcohol appears to cause cell membranes to become less organized.

Out Of Balance

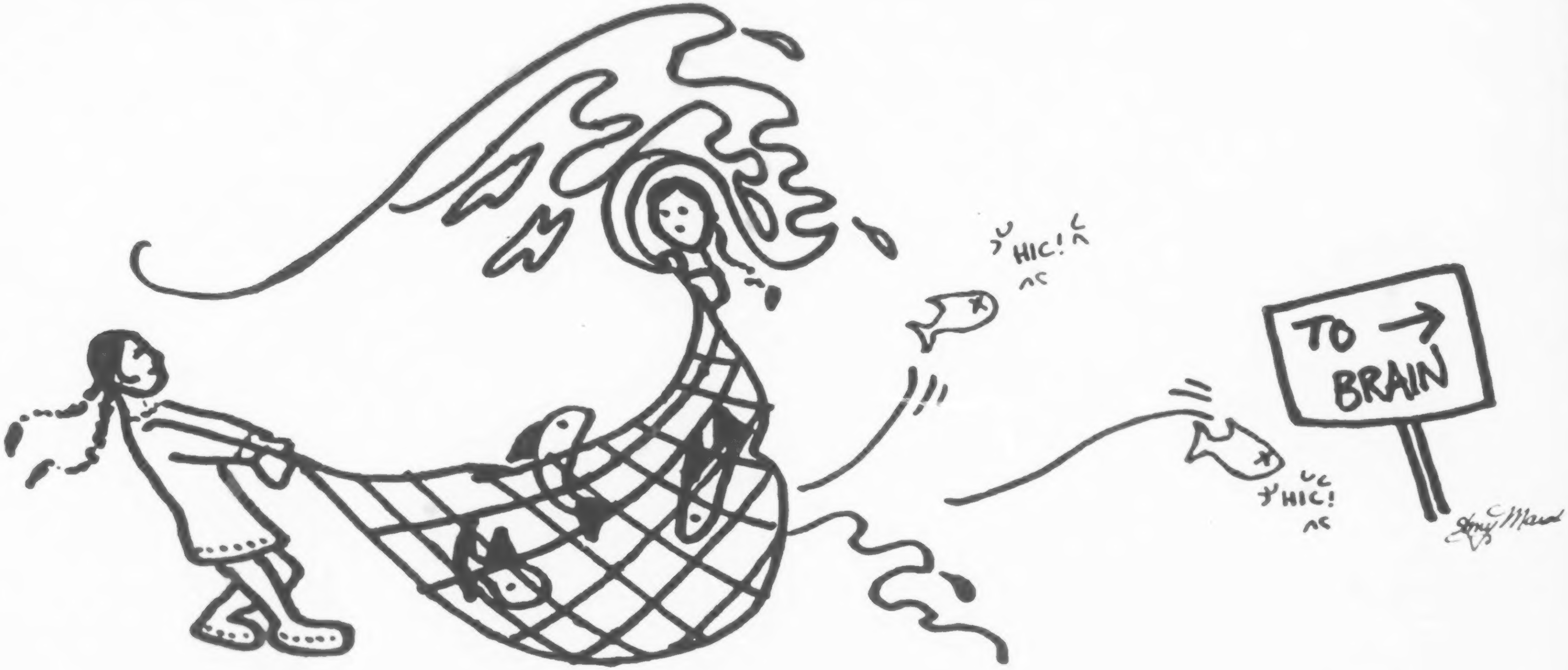


Cross Section of Cynthia's Brain


Forebrain □
Midbrain ▥
Hindbrain ▤

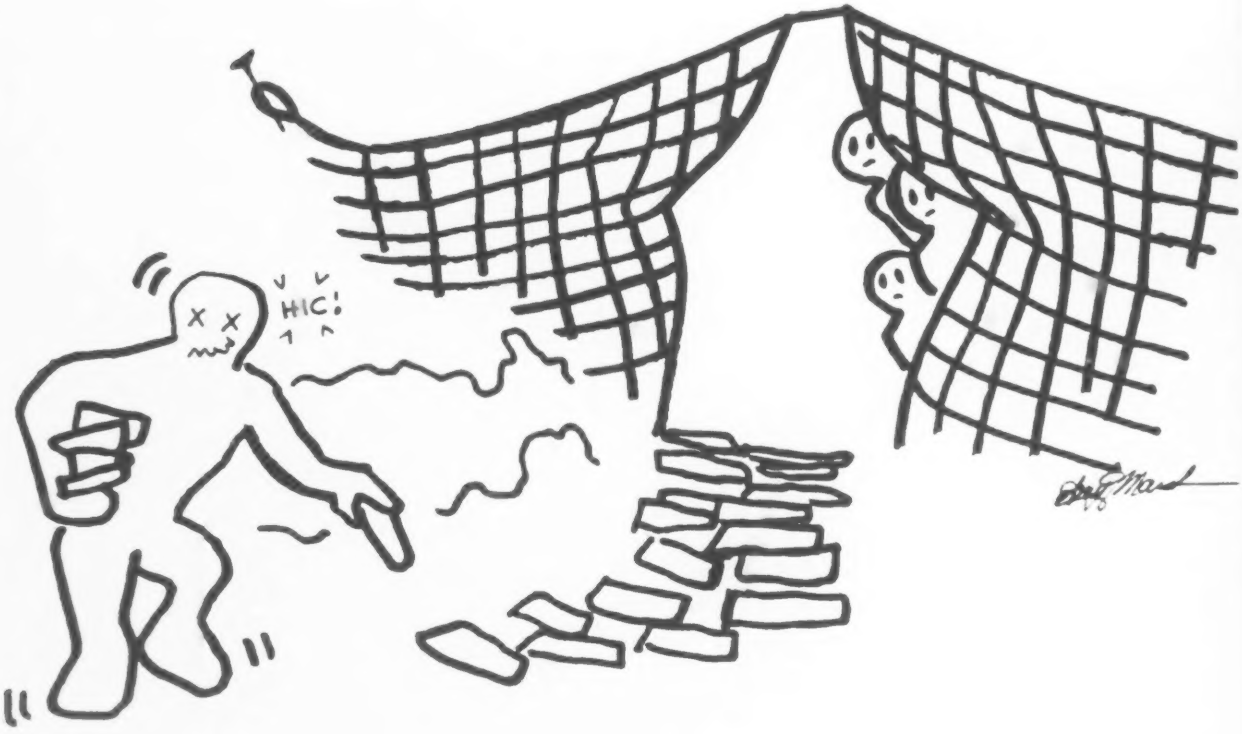
Handout 8

THE BLOOD-BRAIN BARRIER

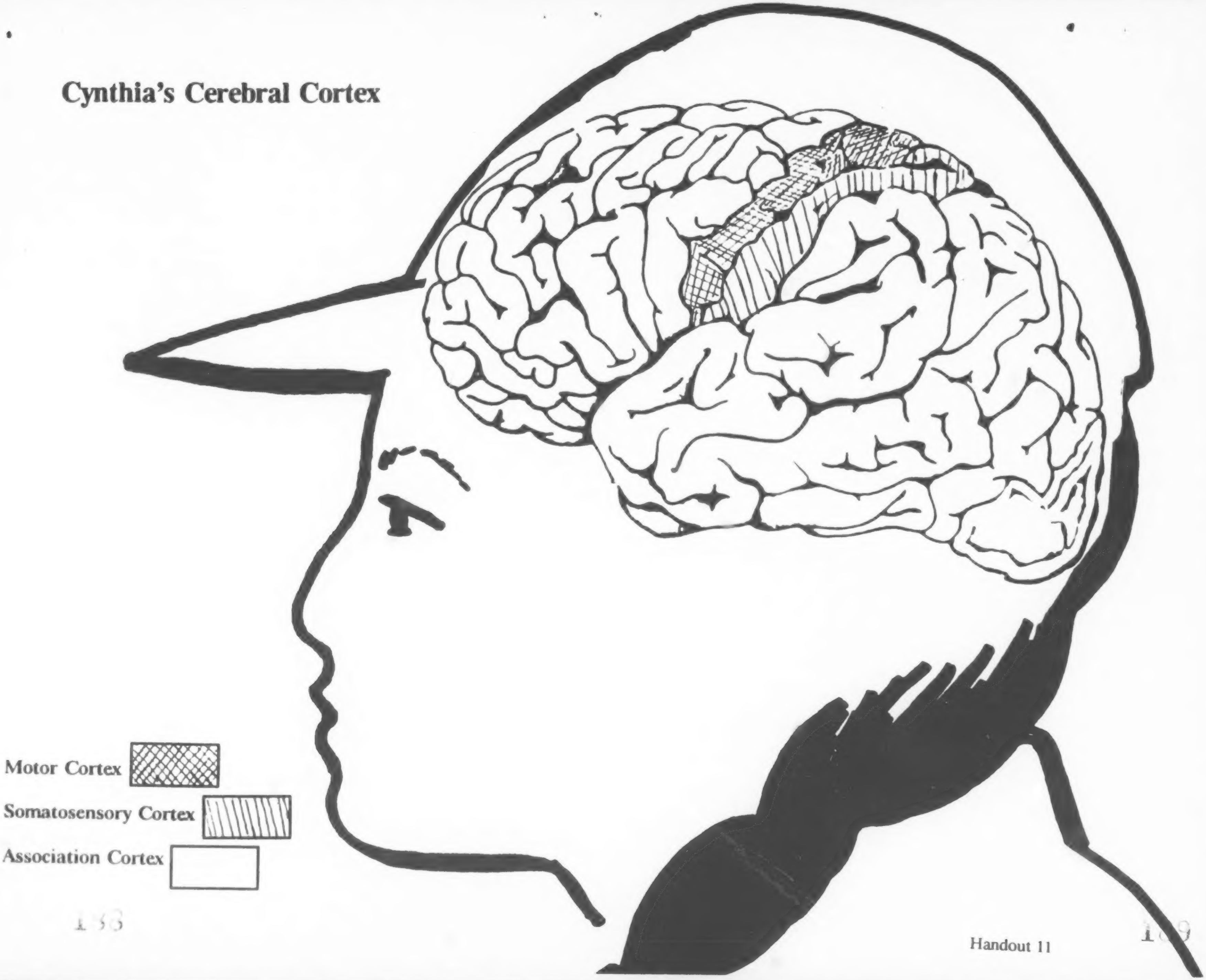

HIC!
HIC!
TO →
BRAIN

Handout 9

Acetaldehyde tends to leave the blood-brain barrier open.



Cynthia's Cerebral Cortex

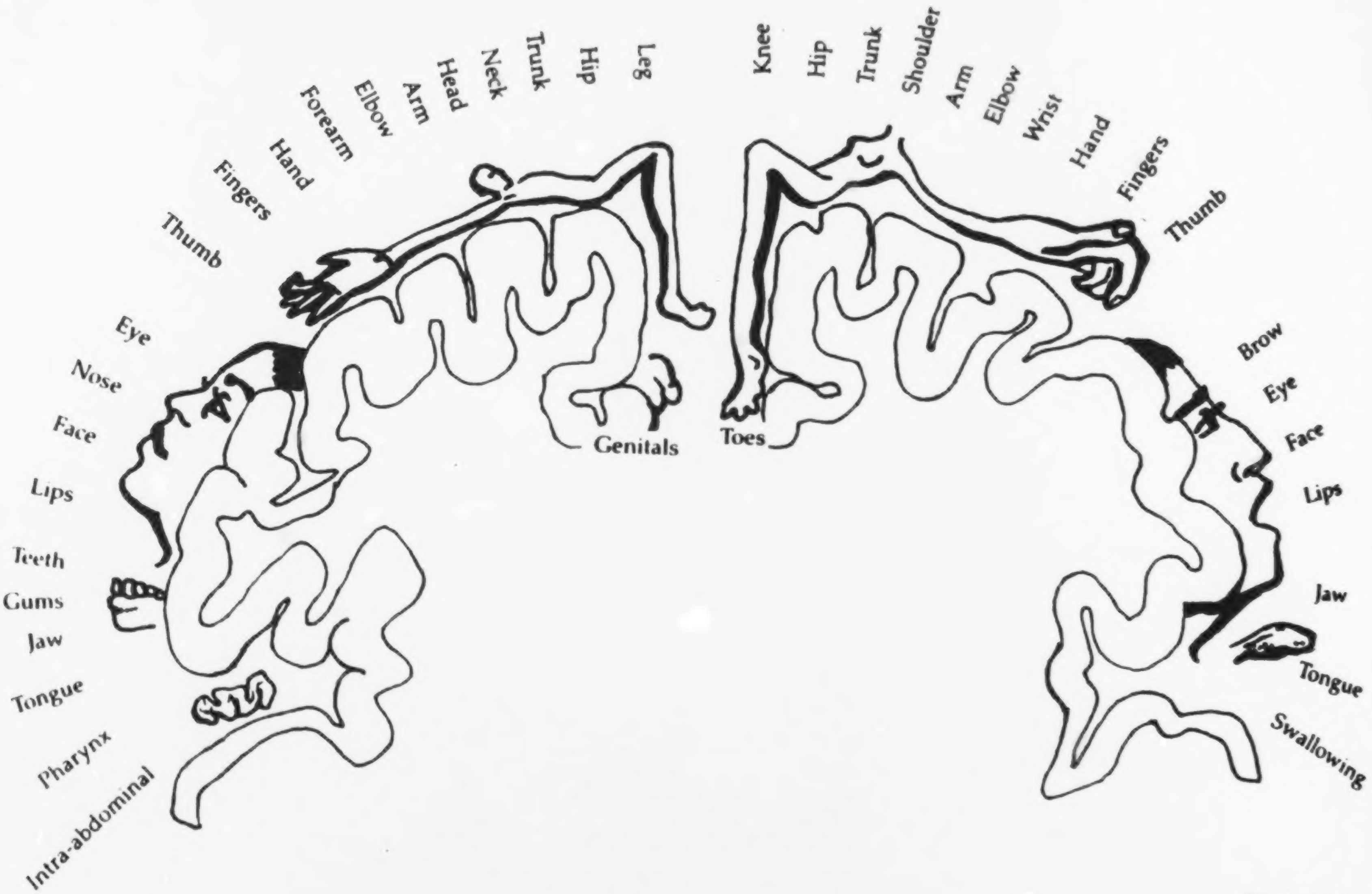


Motor Cortex ▩

Somatosensory Cortex ▥

Association Cortex □

HOMUNCULUS


Intra-abdominal
Pharynx
Tongue
Jaw
Gums
Teeth
Lips
Face
Nose
Eye
Thumb
Fingers
Hand
Forearm
Elbow
Arm
Head
Neck
Trunk
Hip
Leg
Genitals
Toes
Knee
Hip
Trunk
Shoulder
Arm
Elbow
Wrist
Hand
Fingers
Thumb
Brow
Eye
Face
Lips
Jaw
Tongue
Swallowing

GLOSSARY

THE CENTRAL NERVOUS SYSTEM AND ALCOHOL USE

Acetaldehyde	A toxic chemical produced by the liver in the intermediate steps of alcohol metabolism. It is broken down to acetate, water, and carbon dioxide by acetaldehyde dehydrogenase.
Action Potential	A wave of electrical impulses traveling through a neuron to the end of the axon.
Aldehyde	An enzyme that creates acetate out of the highly toxic acetaldehyde.
Amino Acids	The building blocks of which proteins are constructed and the end-products of protein digestion.
Association Cortex	Area of the cerebral cortex associated with complex processes such as thought and language.
Axon	A process of a neuron that conducts impulses away from the cell body. Axons are usually long and straight, and most end in synapses in the central nervous system or ganglia or in effector organs (e.g., motor neurons).
Blood-Brain Barrier	A layer of tissue that surrounds the brain and separates it from the rest of the body. It works to prevent toxins that may be in the blood from entering the brain and possibly causing damage.
Bouton	Bulblike expansions at the tips of axons that come into synaptic contact with the cell bodies and dendrites of other neurons.
Central Nervous System	The nerve cells in the spinal cord and brain.
Cerebral Cortex	Outer layer of the brain covering the two brain hemispheres. It represents the most recent evolutionary development of the nervous system.
Cerebrospinal Fluid	A clear liquid that has similar properties to blood, but without any blood cells in it. It functions to protect, buffer, and fuel the brain. It is squeezed out of the blood vessels in the area of the brain and circulates around the brain.
Dendrite	A branched process of a neuron that conducts impulses to the cell body. There are usually several to a cell. They form synaptic connections with other neurons.
Dopamine	A neurotransmitter that is involved in motor activity and the rewarding effects of certain drugs.
Dopamine Synapses	Connections between individual nerves that rely on the neurotransmitter dopamine as a signal.

Electroencephalogram	A tracing on an electroencephalograph - an instrument for recording electrical activity of the brain.
Enzyme	A protein that accelerates a chemical reaction but which itself does not undergo a net change.
GABA	The amino acid gamma-aminobutyric acid, the major inhibitory neurotransmitter in the brain.
Glucose	A sugar. Glucose is the most important carbohydrate in body metabolism. It is formed during digestion from the hydrolysis of di- and polysaccharides, esp. starch, and absorbed from the intestines into the blood of the portal vein. In its passage through the liver, excess glucose in converted into glycogen.
Glutamate	Salt of glutamic acid.
Homunculus	A topigraphical map of the body that is found in several areas of the brain, each area exaggerating the parts of the body for which it is particularly responsible.
Hypothalamus	A region at the base of the brain that is involved with basic behavioral and physiological functions. It is the center for many of the endocrine functions of the body.
Innate Tolerance	A term used to describe differences in initial sensitivity to alcohol.
Ion	An atomic particle carrying an electric charge.
Lipid	Any one of a group of fats or fatlike substances characterized by their insolubility in water and solubility in fat solvents such as alcohol.
Metabolite	Any product of metabolism.
Motor Cortex	Area of the cerebral cortex that is involved in controlling motor activity (physical movements) of the body.
Motor Neurons	The nerves from the brain that control body movement. They carry impulses that initiate muscle contraction.
Nervous System	An extensive, complicated organization of structures by which the internal reactions of the individual are correlated and integrated and by which the adjustments to environment are controlled. It is separated arbitrarily into two large divisions: 1) The Central Nervous System, and 2)The Peripheral Nervous System.
Neuron	A nerve cell, the structural and functional unit of the nervous system. A neuron consists of a cell body and its processes, an axon, and one or more dendrites. Neurons function in initiation and conduction of impulses.

Neurotransmitter	A substance such as norepinephrine or dopamine that is released when the axon terminal of a presynaptic neuron is excited. The substance then travels across the synapse to act on the target cell to either inhibit or excite it.
Norepinephrine	A neurotransmitter with various regulatory functions, important in arousal and learning.
Peripheral Nervous System	The nerves, ganglia and end organs which connect the Central Nervous System with other parts of the body.
Receptor	A protein in the wall of a neuron or other cells that recognizes and bindsneurotransmitters or other chemical messengers.
Serotonin	A neurotransmitter that affects mood, consummatory behaviors, and the development of tolerance to alcohol.
Somatosensory Cortex	Area of the cerebral cortex that is involved in sensory input for the senses.
Synapse	A microscopic gap separating adjacent neurons.

Evaluation Form - Participant

Name of Unit: ____

Date of Training: ____________ Location of Training ______________________________

Instructions: Please complete this form and turn in to the trainer after completion of the training session

		strongly disagree		no opinion		strongly agree	comments
1.	The Participant Booklet was useful to me during the training	1	2	3	4	5	
2.	The content in the Participant Booklet was easy to understand	1	2	3	4	5	
3.	The activities and examples in the training were relevant to my current job situation	1	2	3	4	5	
4.	The questions in the Participant Booklet helped me to understand the material	1	2	3	4	5	
5.	The classroom application ideas and activities in the Participant Booklet can easily be adapted and used in my classroom situation	1	2	3	4	5	
6.	I learned a lot in this training	1	2	3	4	5	

7. The strengths of the training are:

8. Recommended improvements for the training are:

9. Recommended improvements for the Participant Booklet are:

10. Additional Comments (use back if necessary):

AISES

The American Indian Science & Engineering Society (AISES) is a nonprofit organization dedicated to helping American Indians seek self-reliance through careers in science and technology and to developing technologically-informed leaders for the tribal community. Founded in 1977, AISES now has more than 1,100 professional and student members from 141 tribes. AISES programs include teacher training, math and science camps, curriculum development, scholarships, campus chapters, community education, corporate mentoring partnerships and other activities which enable American Indians to enter math and science-based careers, and to serve the technological concerns of tribal nations.

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